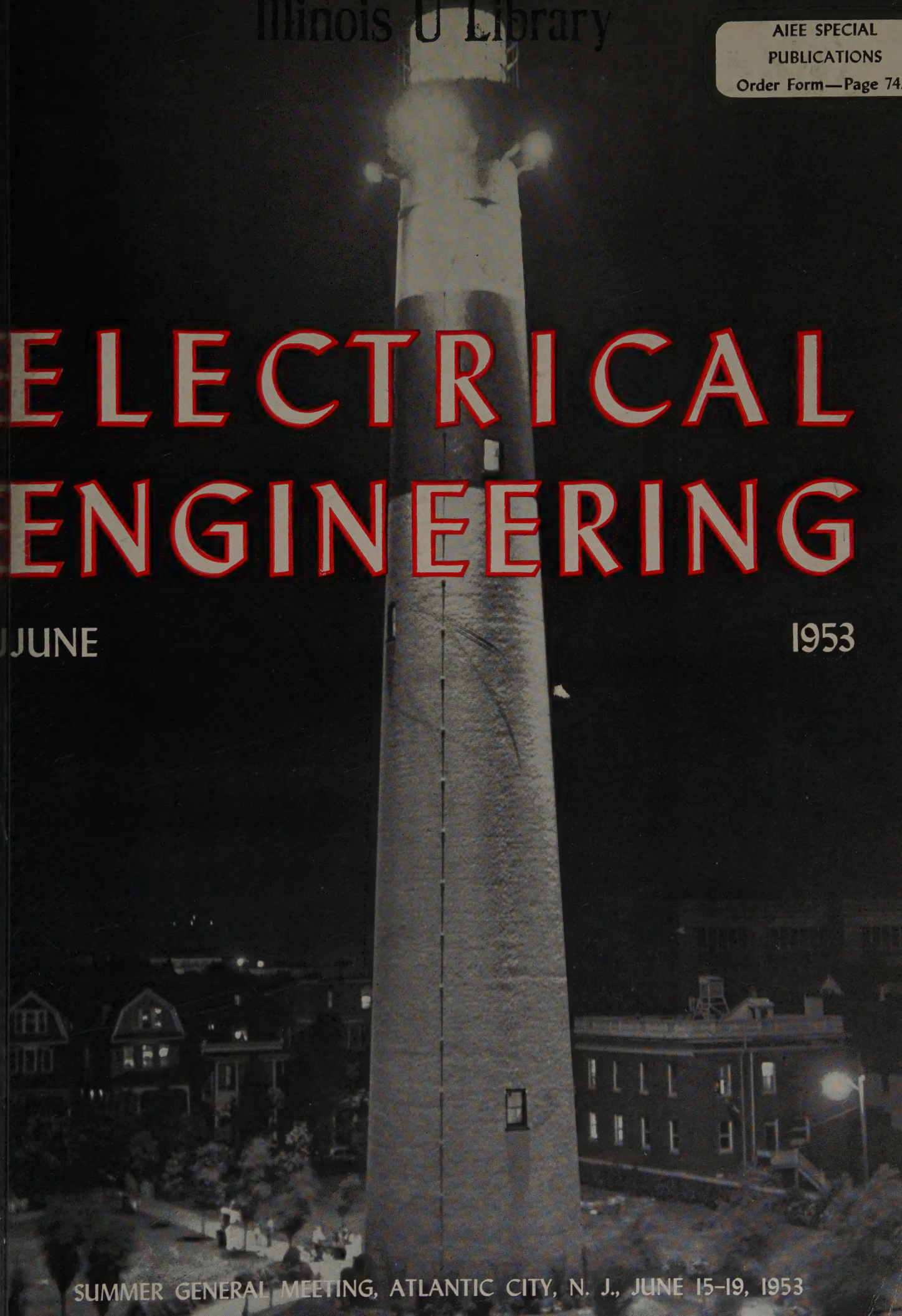

ELECTRICAL ENGINEERING

JUNE 1953

SUMMER GENERAL MEETING, ATLANTIC CITY, N. J., JUNE 15-19, 1953

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ELECTRICAL ENGINEERING

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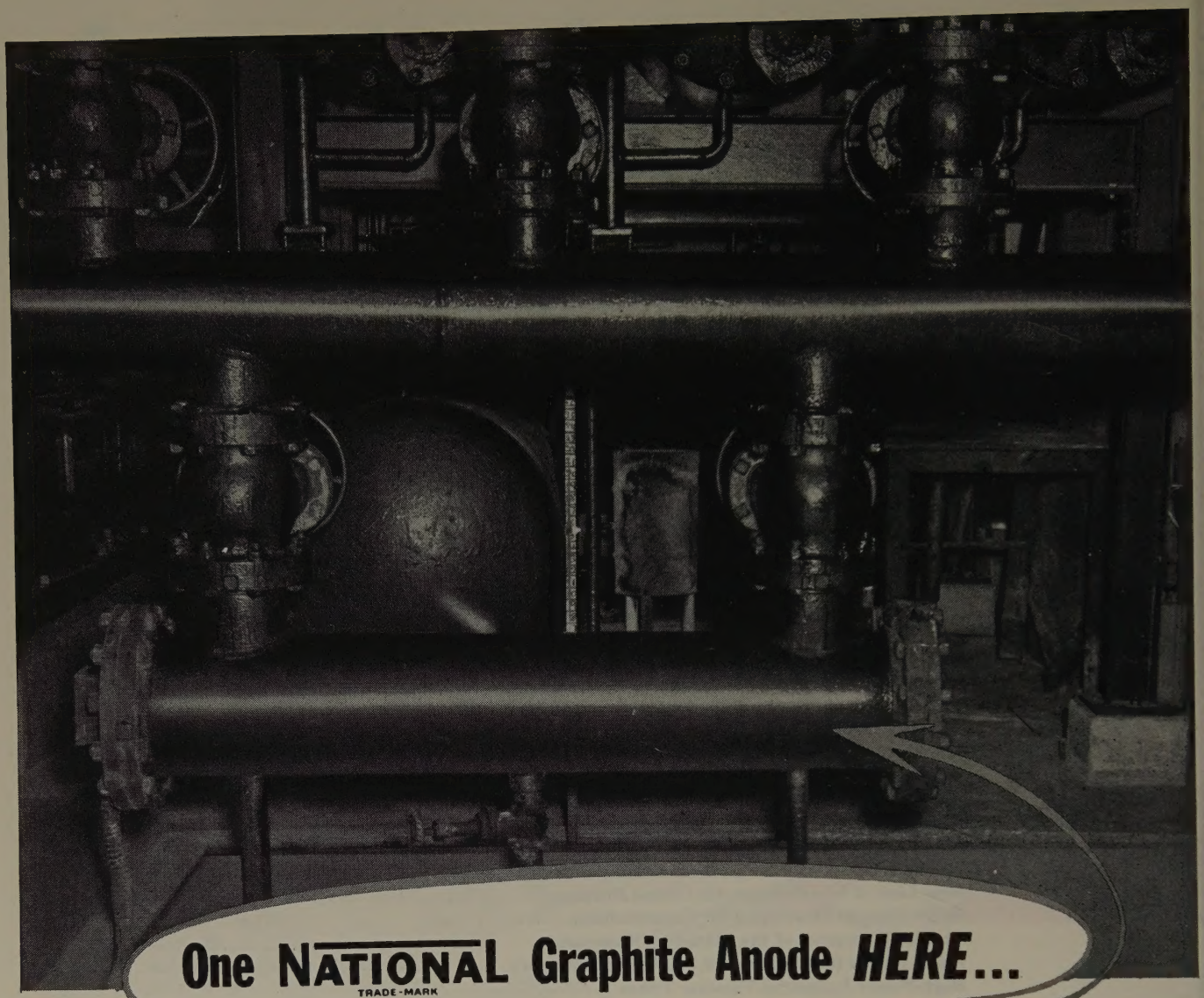

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Report to the Membership

D. A. QUARLES
PRESIDENT AIEE

The formation of an Atomic Industrial Forum, the resignation of Dr. Astin as Director of the National Bureau of Standards, and the latest development in plans for a new Engineering Societies Building are items of current interest to the membership discussed by President Quarles in this report.

ANNOUNCEMENT was made recently of the formation of Atomic Industrial Forum, Inc. This is an organization of individuals and industrial concerns interested in the application of atomic energy to civil uses, particularly for commercial power generation. The purpose of Atomic Industrial Forum as stated in its announcement is "to provide a forum in which industry might develop its best thinking in the interest of the advancement of the peacetime uses of atomic energy; a forum in which industry might develop an informed voice to be heard at government levels as new atomic energy policy is hammered out; a forum, not to serve the narrow interests of a few, but to stimulate the industrial development of atomic energy for the good of all."

With earlier public announcement that an atomic fuel power plant for submarines is moving out of the experimental and into the final design phase, and with a number of important industrial groups collaborating with the Atomic Energy Commission in actively considering the possibilities of atomic reactors as prime sources of energy for commercial power generation, the organization of the Forum is a timely move. While its area of activity is stated to be primarily the United States, similar moves are underway in other countries, particularly in Canada and England.

It is interesting in this connection that prominent people have been variously quoted in the press as predicting first commercial application of atomic power in the United States, some as soon as 2 years, others ranging up to 30 years. This disparity among the experts is a good indication of the uncertainties in the situation. Without trying to outguess the experts as to the timing, and their guesses provide a great deal of latitude, I believe there are some important items for engineers to note:

1. There is a lot of new technology to be mastered.
2. There are important national defense reasons why commercial application of atomic energy should be pushed.
3. The Government is increasingly favorable to such developments.
4. Electrical engineering is certainly one of the main ingredients.

There are factors such as security and the custody of fissionable materials that create pressure in the direction of Government ownership and operation of atomic power plants, a direction that all, I believe, including Government as well as industry, are agreed would not be best in the long run. Already one finds certain sections of the press raising an outcry about atomic power "grabs" much like the water power discussion some years ago. This point of view, which at times smacks of demagoguery, must be faced squarely, and the situation requires broad-gauged and well-informed statesmanship both in Washington and in the industry. There is no question but that atomic energy offers the long-range possibility of serving the common welfare and enriching the nation as a whole. There is no reason why these objectives cannot be achieved within the framework of our present free enterprise system.

One might compare this situation with that presented by air mail 20 or 30 years ago. It seems to me there is a close parallel. Initially the cost of the air mail service exceeded the revenue that could be realized from reasonable rates. There was, however, a strong national interest in nurturing the air transport industry as a basic element of defense. These somewhat conflicting considerations were reconciled in a national policy which in effect subsidized air mail, but did so without destroying the private initiative of the air lines. As a result valuable service is now rendered at a moderate price (even taking into account the concealed subsidy). The free enterprise system has been preserved and the common welfare has been served. These same principles can be applied in working out a national policy on atomic power. Under such a policy there is no question of a "grab." There is, however, the problem of getting the public to understand the situation and there are many questions for engineers and for industrial leaders, which are all the more challenging because not only public convenience, but public defense are involved.

Under these circumstances we in AIEE may take satisfaction in the quality of the leadership that has taken the initiative in organizing the Atomic Industrial Forum. We might note also that the AIEE has a technical committee structure which covers the atomic energy field.

THE ASTIN INCIDENT

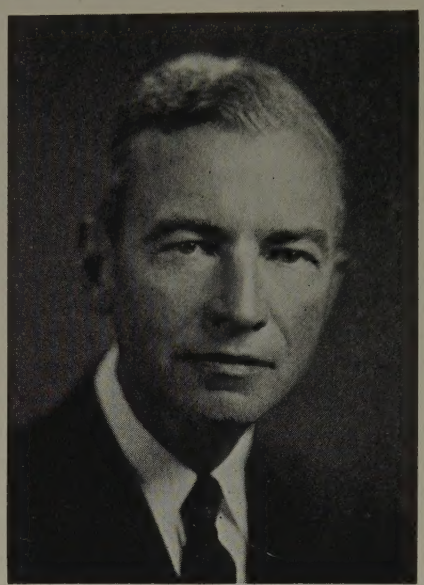
BECAUSE of its somewhat remote connection with the AIEE, I think a brief report is in order on the recent incident in the Department of Commerce leading to the resignation of Dr. Allen Astin as the Director of the Bureau of Standards. The public in general, and engineers and

Excerpts from an address presented at the general session at the AIEE Southern District Meeting, Louisville, Ky., April 22–24, 1953.

D. A. Quarles is president of the Sandia Corporation, Sandia Base, Albuquerque, N. Mex.

scientists in particular, have shown a keen interest in the circumstances of Dr. Astin's resignation. Some of you doubtless saw statements in the press quoting Mr. Sinclair Weeks, Secretary of Commerce, to the effect that he would convene a committee of prominent engineers and scientists to undertake an examination of the organization and functions of the Bureau, and stating that AIEE and other engineering and scientific bodies would be asked to name a representative to this committee.

I assume a general familiarity with the background picture involving unfavorable reports by the Bureau on a battery additive sold by a certain small business in California. These reports were disputed not only by the vendor but later, on his behalf, by members of the Congress. The transcript of the recent hearings before the Senate Small Business Committee is illuminating in this connection. While Dr. Astin was not heard by the committee, it was stated by Secretary Weeks that Dr. Astin's resignation was requested because of his handling of the battery additive matter, and for other reasons the Department at that time declined to disclose. In submitting his resignation Dr. Astin asserted that the Bureau's tests were conducted competently and, in fact, were repeated in order to check its findings. He implied that the results had to speak for themselves.



D. A. Quarles

Without prejudice to the technical merits of the case, it is fair to say that considerable resentment has been voiced (and some of it has been voiced to me) by those who feel that it should not be necessary for the director of a laboratory to consider the political expediency as well as the technical accuracy and adequacy of reports issued by his laboratory. People who view the matter in this way have been anxious that AIEE not lend itself to any device designed to justify the actions leading to Dr. Astin's resignation.

The part AIEE has played and is playing is as follows: On April 3 I received a telegram from Mr. Weeks stating that the National Academy of Sciences acting on his request had appointed Dr. M. J. Kelly, President of Bell Telephone Laboratories, chairman of a committee "to evaluate the present functions and operations of the Bureau of Standards in relation to the present national needs," and asking me to nominate a representative of AIEE to serve, along with representatives of a number of other technical and scientific societies, on this committee. A reply was requested as soon as possible in order that "this study be made at the earliest possible time." After learning from Dr. Kelly that the Astin matter was excluded from the terms of reference of his committee, and after checking with the AIEE Executive Committee by telephone, I prevailed upon Dr. C. Guy Suits, vice-president in charge of research of the General Electric Company, who had served on an earlier Bureau of Standards examining committee, to accept our appointment. My telegram of April 8, 1953, to Secretary Weeks nominating Dr. Suits stated my understanding that the Astin matter was excluded from the terms of reference of this committee. Mr. Weeks' reply of April 10 thanked me for the appointment of Dr. Suits and stated "the Astin matter is excluded from the terms of reference of this committee."

It has been my feeling throughout, and I found it to be the feeling of the Executive Committee, that the AIEE could not fail to respond to the call of a responsible government official for technical assistance, but that we should avoid political entanglements in the process. While I am sure many of us would like to see a competent group examine and clarify the whole Astin matter, it would be very difficult to keep such an examination on a strictly objective plane. In any event, this is not the assignment of the present committee, and from my conversations with Dr. Kelly and Dr. Suits I am satisfied that they will hold the committee on a straight and narrow path of scientific objectivity. As a final safeguard, if one is needed, Dr. Kelly tells me that it has been agreed that the committee's report will be published.

In a later communication Secretary Weeks has announced that acting on the advice of Dr. Kelly and others he has prevailed on Dr. Astin to continue as Director of the Bureau of Standards until next fall and until the committee has made its report. The Secretary went on to say that he holds Dr. Astin in high regard and that he will be offered another equivalent Government position when he is through at the Bureau. Dr. Astin has announced that he has agreed to stay on at the Bureau during the investigation.

Different groups have sent protests to President Eisenhower and Secretary Weeks, and the AIEE has been invited to join in these protests. Believing that it is best to let present actions take their course, we have not done so.

NEW ENGINEERING SOCIETIES BUILDING

The Institute has received from United Engineering Trustees (UET) a definite proposal on planning for a new Headquarters Building which was considered at the Board Meeting on April 23. There has been so much interest in this matter that I shall outline the plan even though it is in the proposal stage. I am sure that the Directors would welcome any views that members may have on the subject.

Stated very briefly, the plan would be to sell the present building, and to buy a plot of land and erect on it a new building suitable for housing not only the present Founde

Societies, but any other professional engineering societies that might elect to join in the plan. It is estimated that around $6,500,000 would be required, more or less depending on the number of societies to be accommodated. Toward this cost UET would be in a position to make available some $2,000,000 from the proceeds of the sale of the present building and from depreciation and other reserves that have been built up over the years. Each of the Founder Societies is considered to have a one-fourth interest in these funds. It is expected that at least some of the societies to be accommodated in the building will have available their own reserve or building funds that might be added to the UET fund. AIEE already has indicated that it could make $300,000 available from its reserves for this purpose. The American Society of Civil Engineers has made a similar move and other societies are currently considering the matter. Each society would be considered to have an equity in the new building equal to its total contribution. AIEE's equity, assuming the foregoing figures, thus would be one-fourth of $2,000,000 plus its contribution of $300,000, or a total of $800,000. The gap between what might be made available through these reserves and the total cost of the building will have to be bridged by contributions or by mortgage. Optimistically, we might make up the whole difference by special contributions. Even if no contributions beyond the reserve funds were received we are advised that it would be possible to secure a mortage covering the balance and under favorable terms. As to location, a legal question has arisen as to whether, under the terms of the original Carnegie gift, the proceeds from the sale of the present building could be used for the erection of a building outside of New York City. While such a ruling would place other cities at a disadvantage in comparison with New York City, it is, I understand, still the view of UET that they are open to propositions from any other cities that wish to submit them.

Under the new building plan AIEE would have adequate space to meet its needs thus eliminating the present unsatisfactory arrangement which locates part of our work in rented space outside of the Headquarters Building. The plan would involve, however, a substantial increase in present rental charges, the amount of such increase depending somewhat upon the extent to which the building costs are covered by contributions rather than by mortgage.

It is our understanding that if UET receives broad endorsement of its present proposal, and all of the Founder Societies, of course, were represented in the formulation of the proposal, it intends to proceed aggressively with the plan. Without anticipating the action of the AIEE Board of Directors,* I think that we can say that it is heartening to see this matter take such a definite and promising turn.

EJC ACTIVITIES

In the area of Engineers Joint Council (EJC) activities there are some matters that I will single out for mention. Following up on the constitutional changes of EJC that became effective just at the end of last year, several other engineering societies were invited to join EJC and three have now accepted, increasing the original five to a present eight. Action by several others is pending. We believe that this is a very wholesome move, particularly as there are today so many matters of common concern to the engineering profession as a whole prominently before us, such as engineering manpower, revision of the Taft-Hartley Labor Relations Act, a new Engineering Headquarters Building, and last but not least, professional unity, to mention but a few. While we can take satisfaction in the EJC moves that have been made, these are weak first steps in the direction of professional unity, and I am sure the AIEE representatives on EJC realize that the Institute looks to them to keep pressing for more effective unity measures.

The Engineering Manpower Commission is continuing its active work under the chairmanship of Mr. Chilton with many interesting projects under way. Also, an EJC special committee on labor legislation has presented a statement to the Congressional Committees dealing with revisions of the Taft-Hartley Act, strongly supporting the provisions of the present Act which guarantee freedom of choice to engineering employee groups. These provisions of the present Act were achieved by united engineering society action, organized by EJC at the time of the Taft-Hartley Act. They are the engineers' Magna Carta and it is of paramount importance that they be preserved.

* *Editor's Note:* The AIEE Board of Directors on April 23 gave substantial endorsement to the UET proposal.

Time Compressor

A "time compressor" has been invented at the University of Illinois. It speeds up words or music without changing tone or ease of understanding. An hour easily can be compressed to 45 minutes.

The machine chops words or music into little sections, throws part of these away, and shoves the rest close together. Compressions of 10 per cent cannot be noticed, while more than 50 per cent of the time can be discarded without destroying understandability.

Scientists have known that words can be understood more rapidly than they can be spoken. Attempts at talking fast fail because the speaker slurs or trips over his words. The invention overcomes this by recording speech in condensed form without changing the pitch as happens when an ordinary recording is speeded up.

The device can stretch time and also change frequency or pitch to a narrow range without affecting time. The message can be transmitted and then expanded back to its original frequency range at the receiving end. This means that in the frequency width offered by a wire or radio channel now carrying one message, several may be carried.

The heart of the device is a revolving drum carrying 4 magnetic tape pickup heads. An endless loop of tape passes around it and over erasing and recording heads. Speed of drum and of tape can be adjusted independently to vary the amount of compression or expansion.

Safety Regulations and How They Affect the Electrical Industry

L. D. PRICE
FELLOW AIEE

Although the electrical industry recognizes the necessity for reasonable safety standards and regulations to minimize potential hazards to the public in the use of electric energy, care should be taken to avoid unnecessarily restrictive or loosely written regulations. Members of the Institute can help by advocating to local authorities the acceptance of nationally recognized codes and standards in local laws and ordinances which regulate installation and use of electric energy.

THIS IS A SUBJECT of such breadth that it is only possible to outline the basic problem, its effect on the electrical industry, and what members of the AIEE can do about it. However, because many members of the Institute are preoccupied by technical and administrative problems that are more pressing at the moment, they may not have an awareness of the serious effects that the problems involved in safety regulations have on the electrical industry. The effects are felt by the public at large, by members of the industry, by the companies or organizations with which you are associated, and by all segments of the electrical industry. Therefore, this article will attempt to focus a spotlight on safety regulations, as they apply to the field of supply and utilization of electric energy, and discuss the effect of these regulations on all of us associated with the electrical industry.

Perhaps safety regulations should be defined before proceeding further. For the purpose of this discussion, safety regulations will be considered as laws, ordinances, codes, or regulations, adopted at the state or municipal level in the interest of safety of the public, and which affect, directly or indirectly, the design, manufacture, sale, installation, use, or maintenance of electrical service and electric equipment.

THE PROBLEM OF SAFETY STANDARDS

IT IS IMPORTANT, throughout this discussion, to accept the fact that the electrical industry recognizes the necessity for reasonable safety standards to minimize potential hazards to the public in its use of electric energy. The National Electrical Code is tangible evidence of this recognition.

The regulatory state laws and municipal ordinances, together with codes or regulations which sometimes are made a part of such laws and ordinances, and sometimes issued under powers granted by the law and ordinance, affect the installation and maintenance of electric equipment in the form of electrical inspection, contractor and journeyman licensing, sales control, and regulations governing the use of specific types of equipment, such as welders, X-ray equipment, and so forth. They are based on the fundamental premise that electrical products should be so constructed, installed, and used that they and their use, are reasonably free from fire and personal hazards. Unless the problems involved in the formulation of electrical safety regulations are considered from a reasonable, practical, nation-wide, and industry-wide viewpoint, local misconception as to how best to achieve safety protection often results in overly restrictive legislation. If these local regulations are unduly restrictive, the basic objective of safety to the public may not be realized and, in addition, unnecessary installation and maintenance costs may be imposed on the user. Restrictive safety regulations erect barriers to the free growth of the use of electric energy throughout the country.

Undoubtedly, much of the improvement in the living standards of the public during the past 50 years has resulted from the growth in the use of electric energy, and it stands to reason that further growth will occur as this useful servant is made available more abundantly to more and more people. Unnecessarily restrictive safety regulations impede this growth, and in many cases, may lessen safety to the public.

ELECTRICAL INSPECTION LAWS AND ORDINANCES

MUNICIPAL ORDINANCES AND state laws providing for inspection of electric installations generally are recognized and accepted as desirable for the purpose of providing a practical safeguarding of the public from electrical hazards to persons and property. In order to fulfill this purpose, the ordinance, in addition to providing for proper administration, should require that electric installations shall be in conformity with suitable standards developed to safeguard persons and property. The National Electrical Code, an American Standard sponsored by the National Fire Protection Association, and developed through democratic procedures by informed representatives of all branches of the electrical industry, including the AIEE, provides these standards. Similarly, the listings of Underwriters Laboratories, Inc., a nonprofit testing organization, indicate conformity of electric equipment with established standards for safety of such equipment.

The behavior of electricity is not affected by city or state boundaries. Consequently, these standards may be specified and applied uniformly throughout the country with uniform regard for safety. For example, the boundaries

Revised text of a conference paper presented at the AIEE Fall General Meeting, New Orleans, La., October 13–17, 1952.

L. D. Price is with the National Electrical Manufacturers Association, New York, N. Y.

many suburban municipalities are streets, and one not thoroughly acquainted with the boundary lines does not know whether he is in one town or the other. In some cases, restrictive electrical inspection ordinances or codes prohibit, or unduly restrict, the use of certain wiring materials and methods recognized by the National Electrical Code, thereby creating a situation where all recognized materials and methods are permitted on one side of the street and only a limited number of wiring materials and methods of installation are permitted on the other. As a matter of fact, the prohibition, by laws and ordinances or by rules issued under them, of the use of certain materials as recognized by the National Electrical Code has the effect of not only increasing unduly the cost of electric installations, but also of effectuating a form of boycott. More important, the effect of some of these unnecessary restrictions has been to cause initial installations to be pared to the bone, with the result that later additions to the wiring system are made, using unapproved, temporary methods, with a consequent increase in hazards.

Adherence to the requirements of the National Electrical Code, and the acceptance of the listings of Underwriter's Laboratories, Inc., not only assures the public of reasonable safety in its use of electric energy, but affords the public a free choice of materials and methods which may be used in their electric installations.

Emphasis should be placed particularly on this distinction between legislation for safety and the free choice by the users of electric materials and equipment. Just as a person should be free to choose between a Lincoln and a Ford automobile, so should a person be free to choose the wiring materials or equipment which he may desire for his electric installation. The only restriction that logically should be imposed by law is that the choice be confined to materials, methods, or equipment conforming to nationally recognized safety standards. In other words, reasonable safety standards may be given the force of law by legislative action; features in addition to reasonable requirements of safety, such as adequacy, provision for future expansion, and quality, should be promoted and sold on the basis of fair competition and in accordance with the American system of free enterprise.

CONTRACTOR AND JOURNEYMAN LICENSING

Licensing of electrical contractors and electricians is, in general, inherently restrictive and is too often conceived and administered with the objective of limitation of free enterprise. Such legislation is contrary, therefore, to the best interests of the public. License fees must be reflected in the costs of electric installations in homes, factories, stores, and all building construction without necessarily increasing the quality or safety of installations. Excessive fees, unreasonable examination requirements, and other similar features of these industry restrictive measures create barriers to free enterprise and obviously result in increased electric installation costs to industry, commerce, and the public, generally.

From a safety point of view, proper inspection can accomplish the objective more effectively, efficiently, and fairly than can licensing. Inspection is made before electric installations are energized; therefore, improper installations, poor workmanship, and violations of the National Electrical Code provisions can be corrected as a result of inspection, with no resulting hazard.

SALES CONTROL LAWS AND ORDINANCES

Ordinances and laws known as sales control or unsafe appliance ordinances are designed to establish control over the retail sale of materials to persons having little or no knowledge of electrical matters who attempt to do their own wiring, or over appliances which can be placed in service by plugging into an existing wiring system. Such ordinances should be limited specifically in scope of application to retail sales to the public, so as not to include industrial equipment.

Experience has demonstrated that the inclusion of industrial and commercial equipment is unnecessary and undesirable, because both the equipment design and the installation are engineered, the installations are made by qualified persons and are inspected, and the installations are maintained by competent personnel. Furthermore, such laws and ordinances should not be applied to regulate competition. Therefore, approvals should be based upon conformity with a single set of national standards and determined by corresponding nationally recognized methods of test. Such standards are available in the standards of Underwriters' Laboratories, Inc., and tests and certification are carried on by Underwriters' Laboratories, Inc.

It is the objective of some such legislation to establish laboratories or to utilize governmental laboratories, or laboratory facilities of local institutions, to certify conformance of electric equipment with local equipment standards. Such requirements, establishing a multiplicity of testing agencies testing to different standards, or using different methods of test, would be apt to lessen the degree of safety now realized, would bring about an impracticable situation in the distribution and sale of electric equipment and appliances, which would destroy, in large measure, mass production and add substantially to costs of marketing such electrical goods.

Loosely written ordinances may result in unnecessary and costly local approval procedures for industrial electric equipment, as well as appliances. Such a case occurred recently in one of our larger cities. There, a new administration officer interpreted the local ordinance in its broadest sense and prohibited the sale and installation of many nationally known industrial equipments, built to conform to nationally recognized standards. The resulting controversy has been resolved since through a reasonable revision of the ordinance, but the case illustrates the necessity for watching the development of such laws and ordinances very carefully.

Standards covering the design, construction, and operation of electric equipments, which lie beyond the normal scope of activities of Underwriters' Laboratories, Inc., are developed by nationally recognized standardizing bodies, such as the AIEE, American Standards Association, Inc., National Electrical Manufacturers Association, and many others. These standards, relating to electrical products, contain safety provisions in the form of specified clearances,

dielectric strength provisions, operating temperature limitations, and others. The electrical industry, as a whole, recognizes the necessity for the safe operation of electric equipment; therefore, these standards are applied broadly and voluntarily in the design, manufacture, installation, and utilization of these products and materials.

REGULATIONS AFFECTING THE USE OF SPECIAL EQUIPMENT

STATE LAWS, MUNICIPAL ORDINANCES, and regulations of governmental commissions sometimes include restrictions on the installation and use of industrial equipment, such as welders, industrial X-ray equipment, induction or dielectric heating equipment, and other miscellaneous equipment, which may result, through their misuse, in industrial hazards, influence communication facilities, or otherwise be construed to affect the public welfare. Such laws, ordinances, and regulations should be reasonable and not unnecessarily restrictive.

APPLICATION OF NATIONALLY RECOGNIZED STANDARDS TO SAFETY REGULATIONS

MANY OF YOU HAVE devoted many hours of arduous work, in co-operation with other informed representatives of the electrical industry, in the development of nationally recognized industry and safety standards. Prominent among these standards is the National Electrical Code. It is applicable wherever electrical safety installation standards are needed. The electrical industry leads all other industries in the development of this comprehensive, national safety standard. It would appear that, having such a standard available for use, local authorities would seize the outstanding opportunity to utilize it effectively. But what happens?

The National Electrical Code, and other nationally recognized codes and standards are used by the local government, to be sure, but in some cases only as a starting point—a steppingstone for the creation of a monument to local creativeness.

The local authorities take the standards as a basis for local regulations but start tinkering with them. The pet ideas and private dislike for certain types of materials, on the part of those in authority, are written in. Pressure groups of all kinds attempt to mold the regulations so as to improve their positions. Local committees are set up and although these frequently include professional people, they generally do not have a specialized experience with safety matters and may be unfamiliar with the preparation of standards. The result is that such committees may, in good faith, emasculate the standards in the course of preparing local regulations.

At times, when ordinances are written, portions of the standards are copied without any intent to change the meaning, but are given some presumably purely editorial revision which inadvertently twists the entire sense.

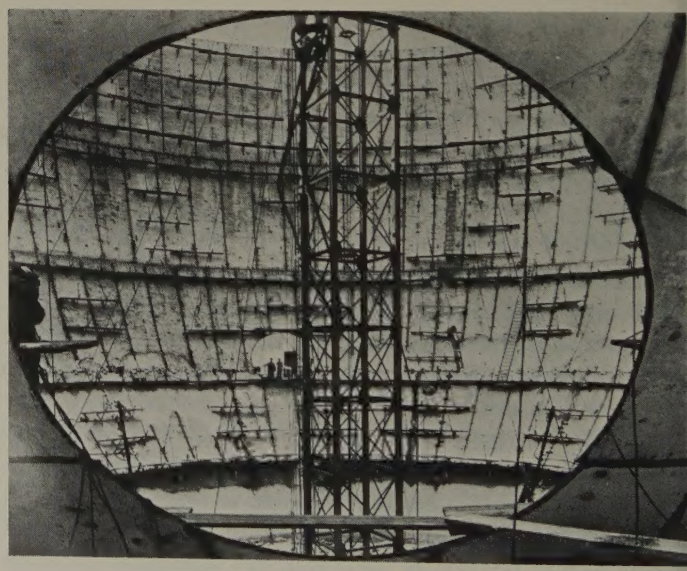
Moreover, when one city adopts a new safety ordinance, other surrounding localities frequently follow suit, and any bad features are copied along with the rest, thus multiplying the undesirable effect. Sometimes even typographical errors are thus copied.

All these forces combine to upset the effect contemplated in the preparation of the national standards. Even if, by some happy chance, a local code different from the national standard will achieve equal safety, the simple fact of such differences tends to defeat the economy and efficiency that are possible through the use of a single universal standard.

HOW THESE REGULATIONS AFFECT THE ELECTRICAL INDUSTRY

WE ARE ALL A PART of the electrical industry, whether as individuals, as companies, or as organizations, and no matter with what phase of the electric power supply and utilization industry we may be associated, we are all tied inextricably with the cash register of the industry—the watt-hour meter. The more meters that are in service and the faster the disks rotate in response to greater demands for electric energy, the greater the prosperity of the industry as a whole. And the industry cannot prosper unless the supply, installation, and utilization of electric energy provide reasonable safety to the public, in addition to its other virtues. It is only through the alertness of all of us connected with the electrical industry to the pulse of the local administrative authority that these unnecessarily restrictive safety regulations may be avoided. As recognized authorities in the field, members of the Institute can aid materially in the solution of this problem by advocating to local authorities, having jurisdiction, acceptance by them of nationally recognized codes and standards in local laws and ordinances which regulate the installation and use of electric energy.

Atomic Powerhouse



Large opening, resembling an eye, permits inside glimpse of gigantic steel sphere, under construction near Schenectady, N. Y., which will house an atomic power plant for submarines. Circular hole is for airtight entrance lock. Opening for another lock is seen on opposite wall of sphere. Rising in middle of sphere is base of 400-foot tower, used for erecting huge, inch-thick steel plates which comprise sphere

Wheatstone Bridge for Admittance Determinations

H. P. SCHWAN
ASSOCIATE MEMBER AIEE

KARL SITTEL

A-C WHEATSTONE BRIDGES, which provide high accuracy for resistance determinations, have been described in the literature in the past. Little attention has been given to bridges which combine high absolute accuracy in reactance or capitance with accuracy in resistance. This is especially true for low frequencies, and is in part due to the difficulty to determine the reactance of conducting materials at low frequencies. Another reason is the unavailability of variable-resistance boxes whose distributed inductances and capacitances are sufficiently well known to eliminate their effect on the reactance to be measured.

A Wheatstone bridge has been built which permits resistance and capacitance determinations within the frequency range from 10 cycles to 200 kc. It is built around an equal ratio arm and provides an amplifier section which contains sufficient filtering elements to cut down noise level to less than 1/10th of a microvolt. The smallest bridge output voltage which can be detected, is about 0.03 microvolt. Its maximum sensitivity in resistance is about 10^{-5} per cent for a bridge input voltage of 1 volt. Its maximum sensitivity in capacitance is given by the product of resistive sensitivity and loss tangent. The bridge is able to permit absolute resistance determinations accurate to 0.1 per cent in the range from 10 ohms up to 100,000 ohms, and with reduced accuracy up to 10 megohms. Its capacitance range extends from 0 to 1,000 micromicrofarads, permitting readings exact within 0.1 per cent over most of its range and extends up to 10 microfarads with somewhat reduced absolute accuracy (maximum error 1 per cent).

A major problem in the development of the bridge was the calibration of the reactance of the variable-conductance box which is used in one arm of the bridge. This problem is important in view of the fact that not only static capacities exist, but also inductances, simulating negative capacities which can be quite large. Especially at low-resistance settings this inductive correction is large and in this case exceeds more than 1,000 micromicrofarads negative capacity for resistances near 10 ohms.

In possession of such a reactance calibration it is possible with this bridge to carry out reactance determinations of highly conducting materials either directly or by substitution technique. The reactance calibration of the box is based on a step-up principle which expresses finally the effective capacities for all dials and each dial setting as they appear at the output terminals of the box in terms of one single unknown capacity. Knowledge of this unknown is obtained from a comparison with one standard of known reactance and resistance. However, it was found that the unknown capacitance value was not independent from the conductivity of the standard. Measurements with five different standards prove it to change linearly with the conductance of the standard. This effect is caused by the small inductance which connects the conductance box with the bridge. The detailed theory, which resulted from the careful consideration of all inductances, not only inside, but also outside the box, proved to be finally in complete agreement with the experimental performance of the box.

The theory shows that the net change in the reactance of the conductance box which takes place when its dials are changed from zero can be expressed by a capacity:

$$C^B = \sum C_{\mu,\nu} - L_0 G^2 - 2L_0 G_0 G$$

where $\sum C_{\mu,\nu}$ is the sum of all dial capacities as given by the calibration of the box, L_0 the inductance of the lead which connects the conductance box with the bridge. G is the conductance setting of the box and G_0 the residual conductance of the box when all its dials are set at zero (in this case 100 micromhos). The terms L_0G^2 and $2L_0G_0G$ are small compared with $\sum C_{\mu,\nu}$ as long as G is not too large. Under these conditions the effective change in the capacitance of the box is a good approximation, identical with the algebraic sum of the changes in capacitance of all the dials whose settings have been changed from zero. However, the term L_0G^2 will not be negligible when G exceeds values of about 10,000 micromhos. By use of the results of this theory, the accuracy of the corrections can be brought to the same order of magnitude as the precision with which the bridge balance can be determined; to do this it is necessary to determine the various inductances in the bridge with an accuracy of better than 0.001 microhenry.

The calibration permits in principle to determine capacitances of samples of 10 ohms resistance exact within less than 10 micromicrofarads, and of sample resistances of 1,000 ohms within better than 0.1 micromicrofarad. The sensitivity of the bridge permits carrying out such determinations at low frequencies within the limits as given in the foregoing. Its present performance can be characterized by the fact that it permits, for example, inductance measurements exact within 0.0001 microhenry.

The reactance calibration of the bridge has been performed at various frequencies and was found to be frequency independent for all resistors greater than 100 ohms. A small dependence on frequency was observed in the range from 10 to 100 ohms. Its existence is due to frequency dependence of inductance (varying skin effect) as it appears in some low inductive connecting bars in the bridge.

The bridge is currently used for the study of the dielectric properties of biological material at low frequencies.

Digest of paper 53-127, "Wheatstone Bridge for Admittance Determinations of Highly Conducting Materials at Low Frequencies," recommended by the AIEE Committee on Electrical Techniques in Medicine and Biology and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953. Scheduled for publication in AIEE *Transactions*, Volume 72, 1953.

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Trends in Detection and Measurement of Radioisotopes for Medical Purposes

J. W. HITCH

Radioisotopes in increasing quantities and varieties are available to the medical field where they are being used in radiation therapy, diagnosis, and research. To determine the movement of radioactive materials in the body, specialized equipment is necessary as well as newly devised techniques for its handling.

SINCE THE ADVENT of the nuclear reactor, radioisotopes have been made available to the field of medicine not only in greater quantities, but in greater varieties. Several radioisotopes are now coming into wide usage, such as Gold 198, Iodine 131, and Phosphorus 32 in radiation therapy; Sodium 24 and Iodine 131 in diagnosis; and Carbon 14, Potassium 40, Sulphur 35, Copper 64, and others in medical research.

It is commonly known that certain compounds containing phosphorus or iodine are selectively absorbed either by certain organs or by diseased tissue. If radioactive phosphorus or iodine is used, it is possible frequently to locate and determine the limits of a tumor with a suitable radiation detection instrument. If radioiodine in the form of potassium iodide is introduced into the blood stream, part of it will be removed by the thyroid gland. The more active the thyroid, the more rapidly and completely the process is accomplished. Also, sodium chloride labeled with Sodium 24 can be injected into the blood stream to study the movement of blood throughout the circulatory system.

To determine the movement of radiomaterials in the body with accuracy, it is necessary that specialized detection equipment be employed. It is therefore recognized that if the maximum benefits from radioisotopes are to be fully realized, the investigator should appreciate the advantage of proper instrumentation. For this reason, an effort has been made in this article to review the latest developments relative to successful techniques for medical applications, not only those presented in the literature, but also that information obtained from conferences with manufacturers and actual visitation with users of radioisotopes.

For the benefit of those unfamiliar with radiation measuring techniques it may be desirable to review briefly the various types of detectors and to indicate why certain types are selected for specific applications. We shall consider only the detection of beta and gamma radiation which is characteristic of those isotopes currently being used in medicine.

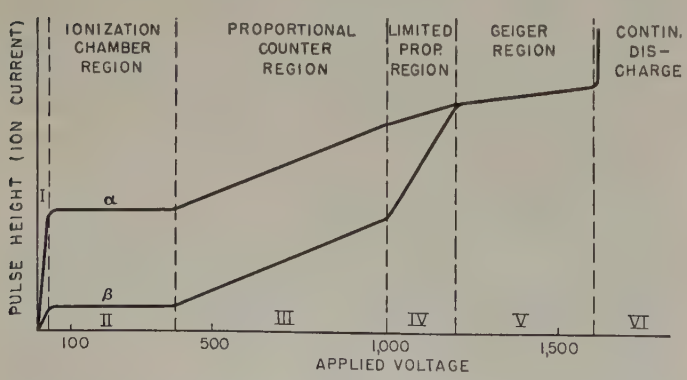

Figure 1. This graph illustrates how ion current increases with applied voltage between two electrodes in a tube filled with ionizable gas

ION COLLECTION IN AN ELECTRIC FIELD

ALPHA PARTICLES produce thousands of ion-pairs per centimeter in traveling through ordinary air, while beta particles of similar energy produce only a few hundred per centimeter. Gamma rays and similar electromagnetic radiations, such as X rays, are also capable of producing ionization in gases but do so indirectly. They cause electrons to be ejected from atoms of molecules in the gas or in other substances they may encounter. These secondary electrons produce the ion-pairs that make it possible to detect electromagnetic radiations.

If a sufficient voltage is applied to a pair of electrodes surrounded by an ionizable gas and an alpha particle or beta particle (or, in fact, any ionizing particle) is permitted to enter the chamber, each of the ions produced from the ion-pairs will travel toward the electrode of the opposite sign. As a result, a charge will collect on the electrodes and the meter will indicate a current. This voltage region, designated as *II* in Figure 1, is commonly known as the "ionization chamber region."* If the applied voltage is increased, the ion current is found to remain relatively constant. This plateau continues until a voltage is reached at which the initial ions will produce secondary electrons. The result is that more ions are now reaching the electrodes than were present in the original ionizing event and the charge now collected is no longer independent of the voltage. If the applied voltage is increased further, more and more secondary ions are created and the curve of ion current increases with the voltage. This voltage

* If the applied voltage is less than this minimum, as shown in Region *I* of Figure 1, the ion-pairs recombine and no charge is collected on the electrodes.

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range, Region *III* in Figure 1, is referred to as the "proportional region." It is noted that the slope of the curves due to alpha radiation and that due to beta radiation is the same. The two curves are displaced in the vertical direction because of the different number of primary ions formed by the different types of radiation throughout Region *III*.

It would appear that if the voltage is further increased, this process of secondary ion production caused by the acceleration of ions toward the collecting electrode would continue to increase the charge or pulse size indefinitely. However, since the central electrode is positively charged, negative ions are swept out of the collecting gas leaving behind positively charged ions. These ions give rise to what is known as a "space-charge effect," and the resulting positive ion sheath has the additional effect of apparently increasing the diameter of the central electrode and reducing the electrostatic field intensity in the counter tube. These factors limit the number of ions which may be collected at the electrodes. As a result of this phenomenon, the multiplication of secondary ionization cannot continue to increase indefinitely as the applied voltage is increased.

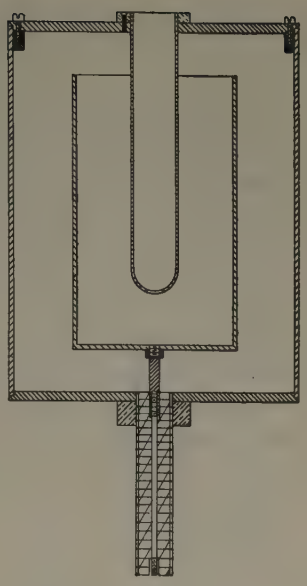

Figure 2. Diagram of the Braestrup chamber for 4-pi sample counting and which operates in the ionization region

The region where the proportionality diminishes between the ion currents collected for alpha and for beta radiation at a given voltage is known as the region of "limited proportionality" and is designated as the Region *IV* in Figure 1. As the voltage is further increased it is found that the charge collected (or the pulse produced) depends no longer on the type of radiation causing the primary ions but only on the voltage applied to the electrodes. This region designated as *V* in Figure 1 is known as the "Geiger region." If the applied voltage is increased further, a point will be reached at which the tube discharges continuously. Operation in this region (*VI*) should be avoided because the counting tube may be damaged if this happens repeatedly.

METHODS OF RADIATION DETECTION

Ionization Chambers. The ionization chamber is one of the earliest devices used for measuring radioactivity. It was employed by Madame Curie, prior to the turn of the century, in some of the earliest studies of radioactivity.

In a broad sense, the term ionization chamber may be used to include all counters operating on the basic principle of measuring the ionization current produced when an ionizing particle enters an electric field. However, for reasons of convenience one usually limits the term ionization chamber to include only those instruments operating in Region *II* of Figure 1. Although they are very simple and convenient for measuring radioactivity, ionization chambers have the disadvantage of being able to produce only a very small pulse, thus making it necessary to employ very sensitive electrometer circuits. For this reason, they are used less frequently in diagnostic and therapeutic work than either the Geiger or proportional counters.

The Braestrup chamber, Figure 2, an ionization chamber for 4-pi sample counting and designed by C. R. Braestrup of the New York City Hospitals, is a good example of a measuring device operating in the ionization region. This chamber is now in wide use in both physical and medical research.

Proportional Counters. It can be seen from Figure 1 that if the applied voltage is increased above a certain value, the pulse size is no longer constant but increases with the voltage. The pulse condition is now represented by Region *III*, known as the proportional region. Proportional counters usually are constructed in the form of a cylindrical chamber which acts as a cathode and a central wire acting as an anode (see Figure 3). If the voltage gradient across these electrodes is sufficiently high, the electrons produced in the gases by an alpha or beta particle will move toward the central wire at a very high speed. In Region *III* this speed becomes great enough for the electrons to cause the ionization of other atoms and molecules in the gas.

This multiplication effect serves to produce an enormous pulse compared with that produced in Region *II*. If the voltage remains steady, the multiplication factor is constant and the size of the pulse produced is proportional to the number of ion-pairs produced by the original ionizing particle. For this reason, proportional counters possess the distinct advantage of being able selectively to detect one type of radiation in the presence of other types. However, in routine clinical work it has limited use, since discriminatory counting is not usually essential.

Geiger Counters. Geiger counters have been more widely used in clinical work than either ionization chambers or proportional counters. The counter tube in Figure 3 also may be operated in the Geiger region. When so operated, it is connected with a device capable of indicating only relatively large pulses, but not small ones. Thus the counting rate, through this range, is essentially independent of the applied voltage.

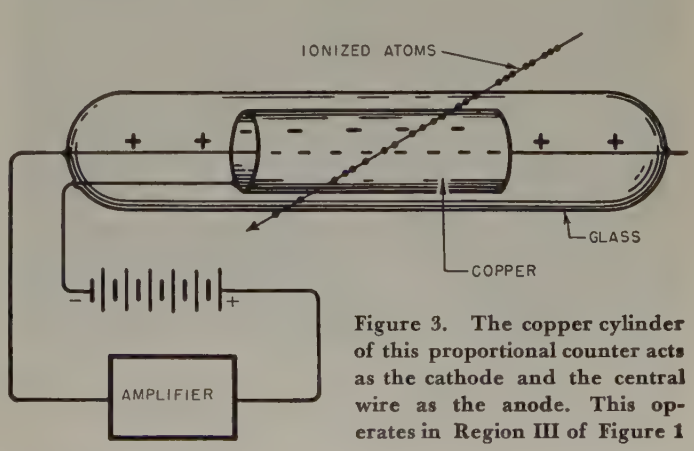

Figure 3. The copper cylinder of this proportional counter acts as the cathode and the central wire as the anode. This operates in Region III of Figure 1

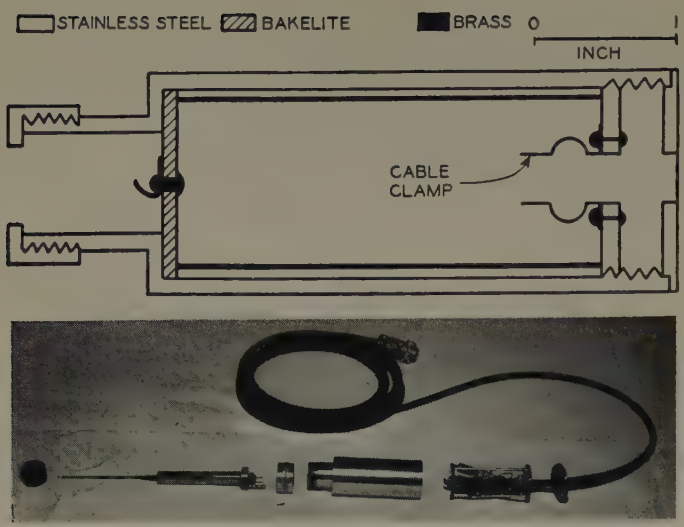

Figure 4. Exploded view and diagram of a probe counter which is used for studying brain tumors

Geiger counters have an advantage over ionization chambers and proportional counters in that the large pulses produced make it relatively simple to design electronic equipment which is reliable and easy to operate. The great variety of Geiger tubes and of possible shielding or collimating arrangements permits the measurement of localized activity as in the thyroid or within tumors. Needle-type Geiger counters may be used for probing in wounds for radioactivity or for pin-pointing the activity as an aid during brain tumor surgery.

Specialized Applications of Geiger Counters. Because the wide variety of counters which have been successfully used for thyroid-uptake measurements are well known, this discussion will deal primarily with more specialized techniques.

Boyack, Moore, Clausen, and Marvin,[1] in reporting experiments with radioactive diiodofluorescein employed as a tracer, used a collimated end-window Geiger-Mueller counter to detect the radiation from the Iodine 131 incorporated in diiodofluorescein. It was found that the dye tended to localize in the tumor tissue in concentrations as high as 17 times that in normal brain tissue.

A directional counting system employed by Weiland and Hahn[2] at the Meharry Medical College, consists essentially of two Geiger-Mueller counter tubes placed side by side in a lead housing. One tube is placed directly above an aperture and the other is completely enclosed. The second tube is used to detect the background with its count being subtracted electronically from that of the first. Thus the net counting rate can be directly indicated. This system has been used with radiogold to outline the margin of the liver and spleen, with radiosodium in blood circulation studies, and with radioiodine in thyroid studies.

A method for accurate localization and demarcation of cerebral tumors has been described by Selverstone, Sweet, and Robinson.[3] After the approximate location* of the brain tumor, radioactive phosphorus is given intravenously. Within the periphery of the exposure during surgery, a "control area" is selected in the region least likely to be t site of the tumor. The sensitive volume of the counter introduced into this area and the counting rate record at various depths below the surface. Then the counter moved toward the suspected region until a sharp increa in counting rate is encountered. The counter is th cleaned with a suitable antiseptic in order to preve possible spread of malignant cells, and successive are are examined in a similar manner in order to demarca further the boundaries of the tumor.

Fields[4] reports a probe counter which has been appli to brain tumor studies. It consists of a counter tube wi a relatively large diameter and a long slender prob which contains the electrodes for the counter. The larg portion of the tube provides additional volume for t counting gas and has mounted to it a cathode-follow preamplifier (Figure 4). The output of this preamplifi can be fed into a scaler or a suitable counting-rate mete By use of the preamplifier, it is possible to increase the li of the counter considerably by operating it at the low end of the Geiger plateau. The rate of expenditure of t quenching gas is therefore reduced and the life of t counter tube is extended appreciably. Needle-ty Geiger counters have a tendency to produce spurio counts if precautions are not taken to prevent flexing of t needle, a condition not always easy to avoid if one must probing. For this and other reasons probe counters ha met with varying degrees of success for diagnosis in bra and body cavities studies.

Friedell, MacIntyre, and Krohmer of Lakeside Hospita Western Reserve University, Cleveland, Ohio, report th for detecting small neoplasms, such as may occur in t eye and where Phosphorus 32 is used as a tracer elemer a small end-window Geiger counter has proved qui successful.

Moore and Kohl at the University of Minnesota Medic School, Minneapolis, Minn., have designed a system of bismuth-wall counters connected to a bank of eight scale so that a quick pattern of the distribution of radioactivi

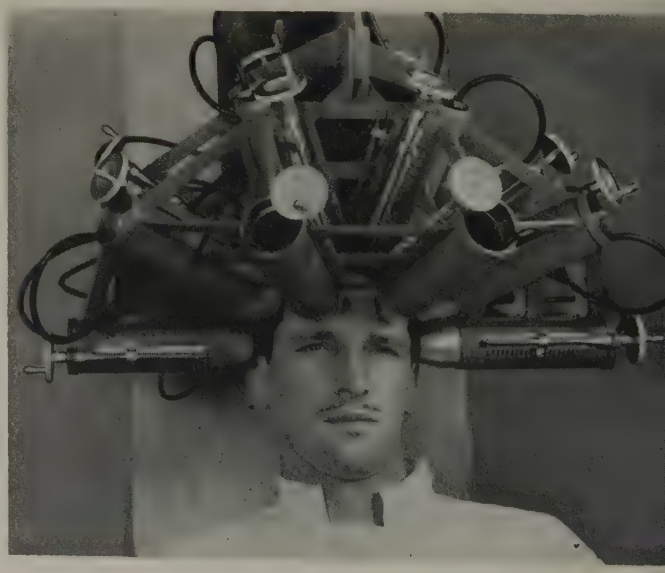

Figure 5. A system of 18 bismuth-wall counters connected to bank of 8 scalers for obtaining a pattern of brain radioactivi

* The location of the exposure to be made of cerebral or cerebellar cortex is determined by neurologic examination and by electroencephalographic and ventriculographic data.

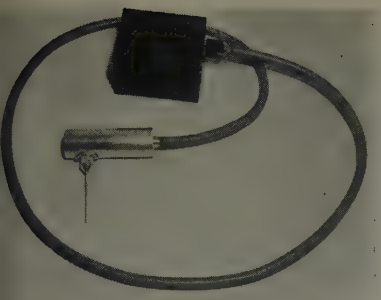

Figure 6. A type of needle scintillation counter for determining tumor locations during brain surgery

ithin the brain may be obtained. The counters are rranged so as to detect radiation from any portion of the ranial area (see Figure 5).

Photographic Detection. Photographic plates were instrumental in the discovery of radioactivity by Becquerel in 896 when he noticed that they became fogged when xposed to certain elements now known to be radioactive. n recent years the improved composition of the emulsions sed has made this method more suitable for the study of ne various ionizing radiations. These emulsions have een used for certain applications, such as the detection nd study of the radioactive materials in the thyroid[5]; or ther portions of the body not too remote from the outer urface. However, their relative insensitiveness makes nem unsuitable for tracer-level studies. Their chief dvantage is their ability to present a graphic picture of the ocation and concentration of radioactive materials in istologic sections. Such autoradiograms are widely used n animal experiments.

Scintillation Counters. The development of the photomultiplier tube has brought a new type of counter to the eld. The scintillation counter is a modern version of the ld spinthariscope.* It utilizes the basic principle that hen ionizing radiation is passed through certain types of rystals, it causes excitation in the crystal. This excitation followed by the emission of light as the electrons fall back n their original orbits within the atom. The light is etected by a photoelectric cell or the photocathode of the hototube and the current thus obtained is multiplied in ie multiplier section of the tube.

Many investigators who have designed scintillation ounters for medical purposes feel that their high sensivity to gamma radiation and their ability to detect adioactivity over a wide range of energy makes them referable to the Geiger counter for many purposes. Most hysicists who have used scintillation counters with favorble results seem to agree that reliable data cannot be btained with a scintillation counter unless a linear amplier and a very stable high-voltage supply are used.† For nese reasons, it is questionable whether reliable data can e obtained with these scintillation counters unless more precise voltage regulation and amplification is incorporated than is usually available in most Geiger-counter systems.

Special Applications of Scintillation Counters. Kohl[7] recently described a needle-type scintillation counter for determining the exact location of tumors during brain surgery (Figure 6). The detector, employing an anthracene crystal and a *1P21* photomultiplier tube, was used to detect the radiations from Phosphorus 32 and Iodine 131. The needlelike probe is made from a duraluminum tube 3 millimeters in diameter with walls 0.1 millimeter thick, and 8 centimeters in length. The interior of the tube is highly polished and contains the phosphor and a small polished plastic rod for piping the light from the phosphor to the phototube. The disadvantage of spurious counts, caused by flexing of the needle in the probe-type Geiger counter, is eliminated.

A scintillation counter, designed by Kohl, Moore, and Chou,[8] has been found to yield an efficiency for the gamma radiation from Iodine 131 of 18 per cent as compared to 2 per cent for Geiger-Mueller counters. (The term efficiency is used to indicate the ratio of gammas detected to those passing through the sensitive volume.) Thus the higher efficiency of the scintillation counter appears to offer a distinct advantage over the Geiger-Mueller counter for tumor localization. The authors point out that when patients are suspected of having an intracranial lesion, isotope-encephalometric studies are performed routinely as the first diagnostic procedure. In 16 patients where the scintillation counter alone was used for the entire survey an accuracy of 100 per cent in diagnosis was realized; on the other hand, a collimated Geiger-Mueller counter showed an accuracy of 70 per cent. Accuracy was based upon confirmation of negative as well as positive tumor findings in subsequent surgery.

Several scintillation counters designed to detect the gamma radiation emitted by Iodine 131 have been built at the Atomic Energy Project at the University of California in Los Angeles. A recent report by Cassen, Curtis, Reed, and Libby[9] is noteworthy. This counter, according to the authors, can easily detect with 1/4-inch resolution the boundary of a region containing only 0.2 micro-

Figure 7. A scintillation counter with directional properties can be mounted in an automatic mechanical scanner for determining the boundaries of active tissue

A spinthariscope is a device consisting of a small tube containing a mixture of zinc lfide and radioactive salt on a screen at one end and a lens at the other end. It was ed in early studies to observe scintillations from radioactive materials.

A linear amplifier similar to the "Model A-1"" designed and used at Oak Ridge ational Laboratory. High-voltage regulation: less than 0.01 per cent change in tput voltage for each per cent change in input voltage; from 105 to 125 volts at any tput voltage setting.

curie of radioiodine per square centimeter. The instrument has been designed with a probe which can be held or mounted in an automatic mechanical scanner (Figure 7). If the instrument is held in the hand, one can make a rather rapid determination of the boundaries of the thyroid gland or other active tissue. The automatic scanner is used to give a graphic outline of the radioactive area within the patient (Figure 8).

A more recent article by Allen and Goodwin[10] describes a technique used at the Wadsworth General Hospital in Los Angeles. The system employs a scintillation counter for in vivo estimation of the thyroid size. A collimated detector and a manually operated scanner are mounted on the adjustable arm of an X-ray stand. The thyroid gland is outlined by using a system of rectangular coordinates on plastic as in Figure 9. After the survey is completed, the counts are transcribed from a strip-chart recorder to the plastic grid. The collimated or "directional" counter used in the system is reported to have a sensitivity 35 times that of a Geiger-Mueller counter.

Another scintillation counter in use at this institution is the "wide-angle" counter for measuring Iodine 131 uptake. This counter is reported to have a sensitivity 100 times that of a Geiger-Mueller counter. The higher sensitivity makes it possible to use very small quantities of Iodine 131, for example, 1 microcurie compared to 50 microcuries, or sometimes more, necessary when using Geiger-Mueller tubes for this purpose.

Wrenn, Good, and Handler[11] at Duke University, Durham, N. C., report a novel technique for localization of brain tumors. The opposed scintillation counters are operated in coincidence to detect and locate concentrations of Copper 64. This isotope has a decay scheme of 54 per cent K-capture, 31 per cent β-emission (0.571 million electron volt), and 15 per cent positron emission (0.657). The positron has a path of only a few millimeters in tissue and a strong point source of gamma radiation, given off in two opposite directions, results from the annihilation.

In the experiments reported, tetrasulfonated phthalocyanine was tagged with Copper 64. The preferential absorption of this anionic dye by the tumor provided a means of concentrating the positron emitter in the diseased tissue. By establishing lines between points where coincidence counting was the highest, it was possible to establish their common point of intersection, and thus indicate the location of the tumor.

Friedell, MacIntyre, and Krohmer of the Lakeside Hospital, Western Reserve University, Cleveland, Ohi report efficiencies as high as 50 per cent for scintillati counting when using Iodine 131 in thyroid studies. addition, successful results have been obtained wi iodinated human serum albumen where the vascular flo and total cardiac output were to be measured. Th sodium iodide crystals are reported to be 5 times mo sensitive than anthracene for detecting the gamma radi tion from Iodine 131. For studies on the back side the eye where the use of a Geiger counter is not practicabl it is proposed to use a curved Lucite cone with a sma anthracene crystal embedded in the Lucite at the ape The base of the cone is sealed to the photomultiplier tub To minimize counting time, a counting-rate comput is used to record with reasonable success the output of scaler. This device electronically computes the countin rate and graphically records it on a strip-chart recorder.

Myers, Department of Medicine, Ohio State Universit Columbus, Ohio, has also experienced favorable resul using a scintillation counter. Comparisons have be made of the relative merits of bismuth-wall counters an conventional Geiger-Mueller counters for clinical purpose It is reported that the bismuth counter is 3 times mo sensitive to Iodine 131 than is the conventional counte and that the scintillation counter is several times mo sensitive than the bismuth-wall counter.

Feitelberg, Mount Sinai Hospital, New York, N. Y has reported successful results with scintillation counte for in vivo counting, and for sample counting uses liqu phosphors* to provide 4-pi geometry. The volume of t phosphor material proves to be a limiting factor since co siderable light is absorbed if the scintillations occur in t portion of the phosphor remote from the photomultipli tube.

Bell, Physics Division, Oak Ridge National Laborator Oak Ridge, Tenn., has suggested that the accuracy locating radioisotopes in biological systems can be in

Figure 8. Graphic outline of radioactive area in patient's thyroid obtained with scintillation counter in scanner of Figure 7

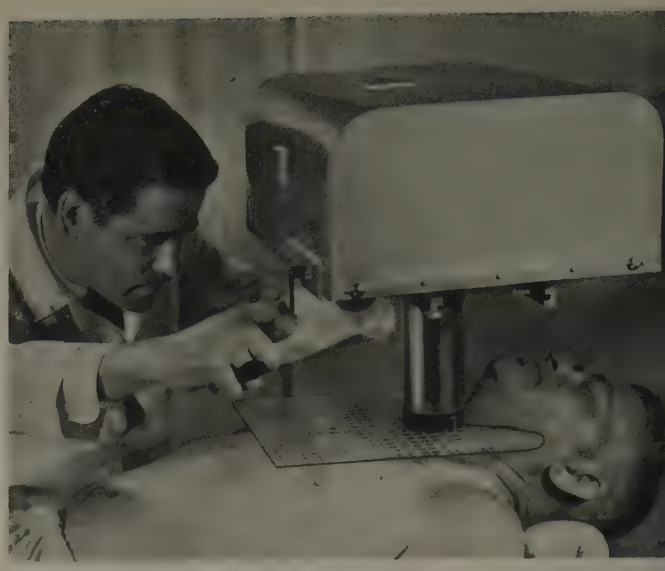

Figure 9. A collimated detector in a manually operated scann being used for outlining a thyroid gland

* Terphenyl mixed with diphenylhexatriene and phenylcyclohexane.

proved by using a scintillation spectrometer (Figure 10). Such devices would not necessarily be as complex as those used in physical research and possibly could be placed on the market at a cost comparable to that of a complete system for reliable scintillation counting. Scintillation spectrometers would have the advantage of being able to detect only that radiation which is characteristic of the isotope being used and would essentially eliminate counting of radiation due to backscatter.

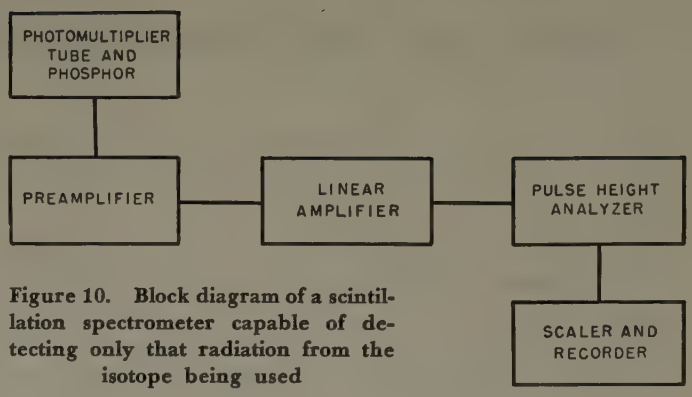

Figure 10. Block diagram of a scintillation spectrometer capable of detecting only that radiation from the isotope being used

SELECTION OF EQUIPMENT

Because of the desirability during diagnosis of keeping the amount of radioactivity to a minimum, measurements are preferably made at low levels of beta and gamma radiations. A highly efficient and dependable counter is therefore desirable.

The gamma efficiency of ordinary Geiger counter tubes has been much improved in recent years by the use of multiple baffles or high "atomic number" (bismuth cathode) walls in their construction. These counters, as do ordinary Geiger tubes, offer the advantage of simplicity of associated circuits compared to the types of circuitry necessary for dependable scintillation counting.

Where gamma-ray emitting radioisotopes are used in tracer quantities, the use of properly designed scintillation counters appears at the present state of the art to provide one method for reducing dosage size to a minimum without undue loss of detection. In addition, a more precise determination of the area of localization appears possible. Sodium-iodide (thallium activated) crystals used in scintillation counters have proved extremely efficient for gamma detection. However, the cost of these crystals together with the extensive circuitry required for reliable operation of the photomultiplier tube may result in the less efficient Geiger counters being preferred, unless specially trained personnel are available.

For the detection of beta-ray emitters, both Geiger and scintillation counters have proved to be equally efficient, but because the scintillation counter system will detect more efficiently any gamma radiation, it is winning a prominent position in the field. Several companies have designed systems especially adapted for clinical purposes, but at present, only a few offer complete systems designed for in vivo counting.

Specially designed 4-pi ionization chambers are being used successfully for in vitro measurements. Both liquid and solid phosphors capable of providing 4-pi geometry in scintillation counters have come into use recently. In addition, 4-pi Geiger counter tubes have been used also but results are somewhat inconclusive.

SUMMARY

For in vivo counting, collimated counters (either Geiger-Mueller or scintillation type) appear to be used very widely. A new development in this field is the introduction of automatic scanning devices that plot the outlines of localized concentrations of radioactivity, for example, of Iodine 131 in a thyroid gland.

Scintillation counters are being developed which promise reasonably satisfactory stability and troublefree operation. Their increased sensitivity for gamma radiation, as compared to Geiger-Mueller counters (either with or without bismuth walls), appears to offer a distinct advantage where very low dosage levels of radioisotopes are required to prevent interference with the normal physiological function of an organ.

Needle- or probe-type counters for use in brain surgery have been devised using either a scintillation crystal or a conventional Geiger-Mueller tube as the detecting element. The scintillation counter requires that the light from the crystal be piped to the photomultiplier tube outside the surgical area. A preamplifier mounted either on or near the probe may be necessary. The Geiger-Mueller needle-type probe may also require a preamplifier and a fairly large reservoir of filling and quenching gas as integral part of the probe to extend the useful life of the counter.

Where beta counting only is involved, the scintillation counter appears to offer no particular advantage over the conventional Geiger-Mueller counter, but where both beta and gamma radiation are, or may be involved, scintillation counters offer considerable versatility in instrumentation. However, the need for high stability of line voltages for reliable scintillation counting is an important factor in selecting counting equipment.

REFERENCES

1. Localization of Brain Tumors With Radiodyes, **Boyack, Moore, Clausen, Marvin.** *Nucleonics* (New York, N. Y.), volume 3, October 1948, page 62.

2. A Manual of Artificial Radioisotope Therapy, **P. F. Hahn.** Academic Press, Inc., New York, N. Y.

3. Clinical Use of Radioactive Phosphorus in the Surgery of Brain Tumors, **Selverstone, Sweet, Robinson.** *Annals of Surgery*, J. B. Lippincott Company (Philadelphia, Pa.), volume 130, number 4, 1949, page 643.

4. Mount, Electronics, and Indicator for Probe Counter, **Theodore Fields.** *Nucleonics* (New York, N. Y.), volume 10, number 5, May 1952.

5. Autographic Localization of Radio-Iodine in Stained Section of Thyroid Gland by Coating With Photographic Emulsions, **Le Blong, Percival, J. Gross.** *Proceedings*, Society for Experimental Biology and Medicine (College of the City of New York, N. Y.), volume 67, 1948, pages 74–6.

6. Improved Overload Response of the A-1 Amplifier, **Magee, Bell, Jordan.** *Review of Scientific Instruments* (New York, N. Y.), volume 23, number 1, January 1952, pages 30–3.

7. Scintillation-Counter Brain Needle, **Douglas Kohl.** *Nucleonics* (New York, N. Y.), volume 8, number 3, March 1951.

8. A Scintillation Counter for Clinical Use, **Kohl, Moore, Chou.** *Nucleonics* (New York, N. Y.), volume 9, number 1, July 1951, pages 68–73.

9. Instrumentation for I^{131} Use in Medical Studies, **Cassen, Curtis, Reed, Libby.** *Nucleonics* (New York, N. Y.), volume 9, number 2, August 1951.

10. The Scintillation Counter as an Instrument for In Vivo Determination of Thyroid Weight, **H. C. Allen, W. E. Goodwin.** *Radiology*, Radiological Society of North America (Syracuse, N. Y.), volume 58, number 1, January 1952, page 68.

11. The Use of Positron-Emitting Radioisotopes for the Localization of Brain Tumors, **F. R. Wrenn, Jr., M. L. Good, Philip Handler.** *Science* (New York, N. Y.), volume 113, number 2940, May 4, 1951, pages 525–7.

Aging of Dry-Type Transformer Insulating Systems

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THE METHOD CHOSEN for evaluation of insulation aging should be representative of operating conditions, applicable to a large range of materials, and readily interpretable in terms of expected life of apparatus. A dielectric strength criterion meets these requirements for dry-type insulating systems. In utilizing this criterion the initial strength of each insulation system is determined at the temperature being investigated. Duplicate samples of the insulating systems are then thermally aged at this temperature and periodic, 60-cycle, 1-minute dielectric strength tests are applied at a value of one-half of the initial hot-dielectric strength until failure occurs. Plotting the hours of thermal aging to reduce the dielectric strength to one-half of its initial value against the operating temperature for a range of temperatures gives the thermal aging characteristics for the insulating system.

Data are presented which show the effect of the gas mediums, air and nitrogen, on insulations with both organic and inorganic base materials and with silicone as well as phenolic resin impregnants. A summary of these aging characteristics is shown in Figure 1.

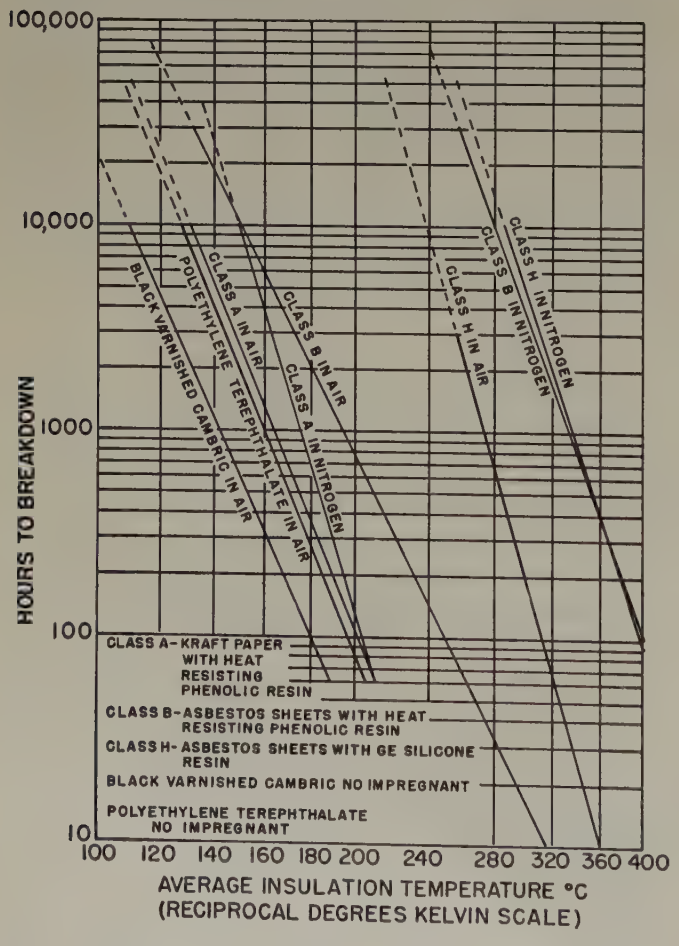

Figure 1. Summary of life characteristics of insulations in air and in nitrogen

Considering available materials, certain technical limitations, aging data, and experience and economics, the following two practical systems of dry-type transformer seem justified:

1. Open 140-degree-centigrade Unit—Ventilated Construction. The individual manufacturer would use class *B* or a combination of class *A* and class *B*, or other satisfactory materials which could be demonstrated by the test method outlined in this article to have a satisfactory life at 140 degrees centigrade.

2. Sealed 200-degree-centigrade Unit—Sealed-in Nitrogen Construction. The individual manufacturer would use class *B* or class *H*, or a combination of them, or other satisfactory materials, which could be demonstrated by test methods outlined in this article to have a satisfactory life at 200 degrees centigrade.

From considerations of ambient changes and usual transformer loading, the value of 20,000 hours may be used as an ordinate on Figure 1 for determining anticipated insulation temperature that will give normal transformer life.[1] Conclusions from this aging data are

1. Additional aging data substantiate the previous conclusion that operation of class *B* in air should be limited to 130-degree-centigrade hot-spot temperature average over 24 hours (140 degrees centigrade maximum).

2. New aging data on silicone insulations in air operated at 225 degrees centigrade maximum temperature show about the same aging characteristics as class *B* in air at 140 degrees centigrade maximum temperature.

3. New aging data on silicones (class *H*) in nitrogen show that for equal thermal aging, their temperature may be increased about 50 degrees centigrade over that of silicones operated in air (ventilated).

4. Additional aging data on class *B* insulation in nitrogen show that for equal thermal aging, its temperature may be increased by about 130 degrees centigrade over that of class *B* insulation operated in air (ventilated).

5. Class *B* insulating systems operating in nitrogen when replaced with relative humidity air for as much as six 24-hour periods of exposure, show minor change in aging characteristics.

6. When operated in a gas atmosphere, such as nitrogen, the aging characteristics of class *B* and class *H* insulation are not significantly different and from this point of view there is little to choose between them.

REFERENCE

1. Aging of Dry-Type Transformer Insulation at High Temperature, **H. C. Stewart, L. C. Whitman.** AIEE *Transactions*, volume 67, part II, 1948, pages 1600–07.

Digest of paper **53-38**, "Aging Evaluation of Dry-Type Transformer Insulating Systems" recommended by the AIEE Committee on Transformers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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Management's Responsibility for Development of Engineers

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Every company's management plan must include a concrete program for the development of its employees. Any such plan for the progress of the engineering personnel, whether along the path of supervision and management or of technical achievement, should consider the development of the engineer's technical and organizational abilities, his professional society activities, and his relationship with society as a whole.

BROADLY, IT IS very true that management has responsibility for the development of engineers, but it is equally true that engineers are in general an integral part of management. Most obvious of all, professional people must carry at all times the principal responsibility for their own development. Nevertheless, professional management is defined as "the task of administration of a business enterprise through leadership of its personnel to achieve its objectives by planning, organizing, measuring, and integrating its human and material resources."[1] Implicit in this concept is the continued development of people so that they progressively can take increasing responsibility and produce contributions of steadily increasing worth. Every management plan, therefore, must have as one component a concrete program for the development of people. This article will consider the portion of a management plan which has to do with the development of engineers.

In general, it would seem that any plan for the development of engineers should provide for progress along four separate but interrelated lines:

1. Development of the technical ability of the engineer.
2. Development of the organizational ability of the engineer and of clear relationships between him and others in the organization.
3. Development of the professional society activities of the engineer.
4. Development of the engineer to exercise proper leadership in society at large.

DEVELOPMENT OF TECHNICAL ABILITY

Selection. First, consider the technical development of engineers. This is a subject to which the General Electric Company and many others have devoted a great deal of thought and attention over the years. Long before the start of this century the General Electric Company embarked on a practice of recruitment of young college graduates with engineering training as opposed to the more conventional plan of waiting for applicants. This program of recruiting brought with it both the responsibility and the possibility of improvement of the engineer through initial selection, training, education, and proper job assignment. In selecting an engineer for industrial employment, it must be recognized that a corporation is a highly civilized component of society if by civilization we mean one of its dictionary definitions: "the art of living together."

Therefore, probably the three outstanding criteria for selection are the distinctly technical attainments as shown by the college record, the professors' analyses of the individual's technical capacity, and a summation of those factors which indicate whether or not the particular individual is likely to be interested in, acceptable to, and therefore happy in an atmosphere of group endeavor. It might be asked why this has anything to do with technical development. The answer is that one of the great strengths of engineering activity in a company such as General Electric lies in the degree to which even the most brilliant individual workers co-operate with one another and can use the help of others to increase their own technical knowledge. It is the author's belief that the heights of technical attainment can be reached today only by a man who by nature can participate freely in give-and-take between at least equally gifted individuals. This point is stressed here as part of the development of technical ability only because it is quite apparent that this kind of ability is needed in many of the pursuits commonly chosen by engineers such as sales or professional management, but it may not be so obvious that it is equally needed for the highest technical attainment. In other words, no matter what the field of the prospective engineer, management's first responsibility is to recruit men who by nature as well as training can participate fully and effectively in corporate activity.

Training. It has been the concept at the author's company for many years that a definite training program is of the first order of importance the moment that the new employee reports for work. Such a training program is represented by what is commonly known as General Electric Test. Rather than assign a student engineer immediately to a given spot in a particular business, it has seemed wise for many years—and still seems wise today—first to explore his capabilities and at the same time to

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allow him to explore the opportunities in a company such as ours. The General Electric Test Program involves a series of rotational assignments in several locations and businesses. The work is intentionally quite varied. Assignments may range from direct work in an engineering office through developmental or experimental test to such activities as the direct testing of major equipment such as our largest turbines, motors, and locomotives. During this time emphasis is placed on four factors: First, it is our concept that every assignment should be such that the man feels a distinct sense of responsibility. Second, the man really should feel that he is producing. Third, every assignment should be such that a man can be and is measured not only on his technical grasp, but by his ability to get things done and to accept responsibility. Finally, each assignment should contribute an opportunity to see a separate phase of the varied work of our large company, thus giving the man as full as possible participation in his choice of future work.

In regard to the work assignment where the man actually begins his productive career, it has been a recognized principle that during this period education should be made broadly available recognizing, however, that engineers vary among themselves as do all human beings. General Electric for years has conducted what is known as a General Course. This is a preliminary orientation program partly concerned with the operation of the company and partly dealing with an introduction to the type of work encompassed in the company's engineering activity.

Specialized Education. Nearly 30 years ago, it was recognized that the company should go much further than this simple course, however, for those who appear interested in and capable of high technical attainment. What has come to be known as the General Electric Advanced Course or Advanced Engineering Program was instituted at that time under the initial direction of the late Dr. Robert E. Doherty. This Advanced Engineering Program consists of two phases. The first is a general analytical course. At the completion of this course, which occupies the first year, the student through lectures and experience with actual problems has been given familiarity with the basic tools used in attacking engineering problems in nearly any field. Obviously these tools are usually only an extension of the basic knowledge obtained in college. Nevertheless, experience has shown that the college education probably necessarily gives substantial attention to fundamentals but provides little opportunity for learning how to handle these fundamentals in the solution of practical problems. The first-year activity gives facility in this latter respect, and at the same time reviews the opportunities for the development of special skills beyond those learned in college.

In the second and third year of the program the student is encouraged to specialize. Some emphasis is given to the problem of making a student still more familiar with advanced technology in many fields. Principal emphasis, however, is towards specialization in engineering fields which meet two criteria: first, are not generally available by experience or association in a number of the company departments; and second, are considered likely to be substantial importance in the future development of existi businesses or in making contributions to society in t shape of new businesses. Examples are the inauguratio of a high-frequency course in 1929, and a course in t systems concept in 1930; also, of advanced study of he transfer and fluid flow in 1932. These subjects, of cours today have widespread application throughout the com pany but at the time truly represented advanced thinkin

This basic Advanced Course was supplemented mo recently by two other courses of approximately the sam level: the first, introduced in 1937, is the Creative Eng neering Program, and the second, in 1946, the Proce Technology Program.

The Creative Engineering Program is directed towar the selection of individuals who have strongly creati possibilities and the development of these creative skil so that the individual will have more than the usual tech nical competence to guide his creative work, and at th same time will have developed confidence in his ability obtain substantial and unusual solutions to difficult prob lems. The course in Process Technology recognizes th difference between the typical background required fo those engaged in the development of materials and proc esses from that required by those who expect to engag in the development of devices or machines. The cours thus is designed to give much the same level of trainin to the man whose background is in the material an process field.

These courses by no means comprise the whole lis There are an Advanced Manufacturing Training Program Marketing Training, and many other functional trainin programs for those whose interests and abilities lie in thes functional fields. These three simply illustrate the gener principle—that is, it is felt that both the company and th individual will benefit by providing for the selected ind vidual a unique opportunity in his first few years with th company to develop special technical skills and confidenc in the application of these skills. One cardinal principl of these courses is that they are given on a participatin basis. While engaged in the Advanced Course the me are doing productive engineering work in varied enginee ing assignments. In such assignments the men are on th payroll of the department in which they work. The cannot continue or complete the course unless they ar doing work satisfactory to the business to which they ar assigned. The company provides instruction, materia instructors, and so forth, and the student is paid durin the classroom time of 4 hours per week as though he wer on a regular assignment. The work is planned, howeve so that approximately 20 hours per week of study an problem work must be put in by the student.

It is recognized that there are many special technic courses which can be obtained directly from establishe educational institutions, and hence the company provid plans whereby men can be encouraged with appropria financial help to improve requisite technical skills by th means. Finally, many of our departments conduct high level courses in specialties particularly applicable to the businesses. These, then, provide what we consid

management's responsibility for formalized technical education for the engineer although this by no means is the limit of management responsibility.

Placement. At the conclusion of the Test training program and subsequent educational programs, the young engineer and the company face an important milestone—that of initial assignment to what is usually a relatively permanent position. Here we encounter a rather interesting phenomenon. It is our considered judgment that by and large there is generally no single business in which a man is likely to be successful. Rather, a man is much more likely to succeed because of the nature of the activity in which he engages and the degree to which it holds and captures his interest, than the particular product involved or the particular growth rate of the business. This may be more apparent if we consider the case of an engineer who has worked on, say, large central station turbines for 10 years and another who has worked on household flatirons for the same period. Both probably have had substantially the same technical education, both have explored numerous fields in common subsequent to their college education; each has some knowledge, however, of his business which is particularly applicable to that business. Therefore, both men are likely to be similar except for a very small overlay of inapplicable experience obtained over a relatively short portion of their productive lives.

On the other hand, there is usually a wide divergence between a highly successful development engineer and a man whose success has lain along the lines of production engineering or the management of engineering work. The attributes which separate such men are the product of heredity, going back long before the man was born, and the total environment of the individual since birth. They are far deeper than a superficial overlay of experience. Therefore, in the initial stages of placement, management has a direct responsibility to see that men do not attempt to choose superficially. Engineers must attempt to analyze themselves for their own capabilities while at the same time management uses the most expert and up-to-date techniques in such analysis, the net desired result being to provide a man with substantial opportunity at the earliest possible date to follow the type of career in which he is most likely to succeed.

Furthermore, management has the responsibility to continue this process. Men inevitably will perform relative to each other along a statistical pattern. Management should provide a rating and individual analysis procedure which will serve as a guide both to the company and the individual to help in determining the individual's present and future progress. The company management should be continually reviewing its technical personnel with an eye to singling out those who show exceptional promise in any field of endeavor and then providing encouragement and help for the individual to increase his effectiveness. Conversely, of course, and equally important, is the analysis for reasons underlying lack of promise, and, if possible, corrective action for these reasons.

As a final step in the technical training program, management certainly has the responsibility to follow up from the results of its planned training and additional programs to determine as accurately as possible the extent to which these programs have helped the individual and through the individual have helped the company. It is easy to assume that selection and training are of value, but it is truly difficult to determine these factors quantitatively.

DEVELOPMENT OF ORGANIZATIONAL ABILITY

Supervision. The second point in a management plan for the development of engineers concerns the development of the engineer's organizational ability and relationships. This is a field in which knowledge and experience are accumulating rapidly but one in which our state of perfection is probably far behind that of technical training. It seems that the first and most important step in this process should be the selection of a young man's supervision. It is all too easy to assume that a young man should be thrown in with others to work out his lot and that the best man will rise to the top. It is the author's personal belief that this is statistically true, but the process can be greatly accelerated by the influence of good supervision. Much has been written on the art of supervision which, of course, cannot be recounted here, but the following four important factors can be noted:

First, the supervisor must know that he is a supervisor and has both authority and responsibility.

Second, the supervisor must have the human characteristics needed to inspire and therefore develop young men.

Third, the supervisor must be technically exacting so that his men learn to keep their thinking processes straight.

Fourth, the supervisor must be equally exacting in requiring that his men plan ahead rather than be content to do the day's work.

Much has been written and said on the subject of the supervisor. We must never forget that each engineer owes an obligation to his superior. The engineer, in making decisions, must put himself truly and objectively in the boss's shoes and try to see things as he sees them. It is a 2-way relationship—the boss must help his men to develop themselves, but he cannot do this unless they truly try to help him execute his responsibility as he sees it.

Individual Attainment. If the man chooses the path of individual technical attainment and seems likely to achieve pre-eminence, management must consider the extent to which he is backed up by appropriate facilities and experimental or developmental programs. If, on the other hand, the man's best path seems that of supervision and management, we are becoming increasingly aware that management itself is a science as well as an art, and it is our responsibility to make available to such men a good technical foundation on which to build their abilities and skills in this area. Courses in management are becoming increasingly available in educational institutions, in associations such as the American Management Association, and in industry itself. The selection of engineers for this training and the provision for such training are certainly responsibilities of top management.

Organizational Structure and Understanding. At this point

as well as throughout the engineer's career, management owes him a clear understanding of the function he is to perform and the manner in which his performance will be measured. Along with all other employees management owes the engineer a proper organizational structure in which to develop. For a more complete discussion of the subject, see T. M. Linville's article, "Management of Engineering Work,"[2] which contains a great deal of material on the development of a proper organization.

It is important, too, that the young engineer should be given an understanding of the organization in which he finds himself. Now this applies, of course, to any employee, but it is particularly true of engineers. By and large the engineer makes his greatest accomplishments by doing what has not been done before; in other words, by breaking established precedents and rules. The engineering mind is prone to take rules and patterns as a challenge to his ingenuity rather than as roads to be followed. Nevertheless, the engineer accepts scientific principles which his experience indicates are applicable. The important thing is that not only must the organization be sound, but that the engineer should comprehend quickly the nature of the organization in which he finds himself and the principles on which it is built; and that the engineer should be encouraged to use it as a tool for his own and his company's advancement rather than as a framework to circumvent by the application of his creative mind.

This is not to belittle the problem of expressing the principles of organization and the practice of management in a truly scientific manner. This can, and will, be done and the engineering approach will help in the process. To the extent that management clearly spells out the true principles of its own work, it can be assured that engineers will help in the process and co-operate toward the common goal.

Creative Drive. Management also owes the engineer a clear understanding of creative drive. This drive is compounded of two factors: dissatisfaction with the status quo, and satisfaction on the part of the individual that he can and should change it. This dissatisfaction may apply equally to parking privileges and accepted beliefs concerning the laws of nature, and the satisfaction of making changes may be almost equal in both fields.

That the creative urge requires inspiration as well as training and understanding cannot be overemphasized. Management must challenge the imagination of creative people. Engineering management must help to guide the technical effort of young engineers and scientists. However, this must be done in such a way that the men are continually and truly inspired to take on for themselves increasingly difficult objectives. In the course of such progress management must understand what the men are doing well enough to see that they keep on the right path while avoiding the danger of stifling their initiative.

Self-Development. In progress up through an organization the process of self-development must be continued with steadily increasing emphasis on the degree to which the man himself should take over. Nevertheless, management has very distinct responsibilities. An engineer or scientis very seldom can develop to his and his employer's maxi mum advantage without certain facilities at his disposal While he must have the opportunity to experiment which requires that proper and sometimes very expensive facilitie shall be supplied, he also must have the opportunity t learn to spend money wisely for such experiment. I general, if engineers are backed up with proper facilitie and properly apportioned developmental budgets, they will be only too eager to do the requisite technical study and to take advantage of appropriate educational oppor tunities. Without such facilities, however, the enginee cannot develop technically.

Nevertheless, it is most important that managemen should so organize that engineers will have more than on path to follow toward both economic and social rewards It must be recognized that some engineers can and should make their greatest contribution in supervising othe engineers and in managing certain segments of the engineering work, while other engineers can perform their greates accomplishments by concentrating on themselves and attaining pre-eminent technical skills as specialists. Both paths to success should be clear, open, and a part of the organization plan. Some men will follow one path, some the other; some may follow both. However, only by recognizing outstanding technical individuals both socially and economically on the same level with their supervisory or managerial counterparts can young men be encouraged each to follow the path which for him is proper. This does not mean that the whole judgment should be that o the individual engineer. Management and those in supervision have a continuing responsibility for guidance in this respect. Increasingly, also, as scientific tools for the measurement of ability and interest of human beings become available, these tools should be applied in making this judgment function properly.

Recognition. Continuous recognition is as important to the engineer as to any other employee. In the case of the engineer, an important factor in demonstrating true recognition involves a continuous process of keeping him informed—informed not only on policies affecting him directly such as technical matters, or pay; but also on general department and company progress, or lack of it on labor relations; profit position; and a host of other such matters.

PROFESSIONAL DEVELOPMENT

THE THIRD AREA of broad management responsibility in the development of the engineer comes in what is rather loosely known as his professional development While the older technical societies are broad in scope there is an ever-increasing number of active societies o more specialized interest. Management should have a definite and constructive program for encouraging engineers to participate in the activities of appropriate societies Such society participation not only represents the attainment of professional and social recognition but in a very real sense broadens and deepens the technical understanding of the engineer.

The preparation of technical papers and participation in the work of technical committees are valuable mental disciplines as well as means to recognition. Nevertheless, this is an area in which good judgment is required and no company can set itself up to dictate. In the author's opinion, however, a company employing engineers should be concerned by and with the extent to which its engineers become members of and have appropriate voices in the local and national proceedings of technical societies. On the other hand, it is self-evident that some engineers must work on highly confidential projects, some classified for reasons of national security, while others are zealously guarded from becoming common knowledge of competition. Other engineers may work on equally important problems or projects which can and should be generally disclosed, thereby contributing to the over-all benefit of society without impairing national security or the competitive drive which is the mainspring of our industrial progress. Management should recognize these factors and, by assistance to the engineer in achieving professional recognition wherever possible, compensate for the occasions when unusual circumstances may prevent such recognition.

DEVELOPMENT OF LEADERSHIP IN SOCIETY

Finally, it seems evident that the management of a company employing a large number of engineers should give substantial thought to and prepare concrete plans for the economic and even the political education of engineers. Much has been said in the proceedings of the technical societies on the extent to which the engineering profession can, does, and should participate in the decisions of government. The first requisite of such participation is economic sophistication; that is, an understanding of basic economics which cannot be obtained except by substantial study of the same kind which is given to mathematics or physics. Hence, part of the program of the General Electric Company is to make available to our professional people—regardless of whether they choose the path of management or technical specialization—the opportunity for study of basic economics. This is done in a practical manner with a variety of courses. Two outstanding courses were prepared outside our company and two internally. One of these (and in many cases more than one) is given to all technical and supervisory people.

In regard to political education, we are now in an era in which the sphere of influence of central government has increased many, many fold. The basic impulses causing this increase in the main have been of an economic nature. Therefore, the understanding of simple economics is a prerequisite to political understanding. This, of course, does not mean that management has the responsibility to teach engineers to have a uniform set of party loyalties or beliefs. Rather, management should see to it that engineers as well as other educated people have not only an opportunity but the encouragement to develop themselves along the lines of understanding the economic and political atmosphere in which the corporation which employs them lives. Without this they cannot be expected to appreciate the degree and extent to which the present social trends can influence and are influencing both the contribution they can make to society and the reward which society feels is appropriate for the contribution. Such education can and often should be supplemented by the encouragement of participation in civic affairs.

SUMMARY: BUILDING BLOCKS OF MANAGEMENT POLICY

To summarize in brief, a proper plan for the development of engineers should include:

1. A plan for their selection.
2. A plan for specialized training and orientation and appropriate evaluation upon first coming to work.
3. A plan for advanced technical education appropriate to the aims and objectives of the company applicable to the first few years of employment.
4. A logical and effective plan of organization involving a minimum of supervisory layers, very few undefined responsibilities, and staffing by men with a clear understanding of their supervisory and management responsibility.
5. A continuous system of properly appraising the contributions of the individual engineer.
6. A strong interest in the engineer and a means for effectively guiding him along either the path of supervision and management or on the path of individual technical attainment.
7. The necessary and appropriate means for assisting the engineer to become more competent in either of the paths described in item 6 beyond that which can be obtained by "on the job" training.
8. A real interest in the engineer and a plan to help him with his participation in professional societies.
9. A plan to interest and stimulate the engineer not only in a field of technical or management attainment but also in the field of economic and political understanding.

These plans then, in the author's opinion, are the building blocks which management must use in discharging its responsibility for the development of engineers.

REFERENCES

1. Problems of Management in a Large Decentralized Organization, **R. J. Cordiner.** "Developing Management Leadership for a Free Society," American Manufacturers Association General Management Series, number 159, 1952, pages 3–17.

2. Management of Engineering Work, **T. M. Linville.** *Electrical Engineering*, volume 71, December 1952, pages 1091–5.

New York–Albany Relay System

A radio-relay system to be constructed between New York, N. Y., and Albany, N. Y., will augment existing facilities between the two cities, according to an announcement by the American Telephone and Telegraph Company, and also will interconnect with the newly constructed Albany-Buffalo microwave system to provide a second radio-relay route westward from New York City.

Initially, the new system will provide three northbound and two southbound channels for television service and one in each direction for protection and maintenance.

Comparative Cost of Distribution Systems

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THE PURPOSE OF THIS ARTICLE is to compare the effect, on the cost of new overhead, open-wire distribution systems, of using either 4.16 kv or 13.2 kv as alternative primary-feeder voltages for supplying load in the same area. The range of load densities considered is 125 to 16,000 kva per square mile. This load-density range is representative, therefore, of heavy-rural to heavy-urban loads.

At a given load density, costs of distribution systems employing either 4.16-kv or 13.2-kv primary feeders are based on a system in which, for either primary-feeder voltage, similarly arranged primary-feeder circuits are extended until 3-per-cent voltage drop, or the kilovolt-ampere loading limit of the primary feeder is reached, whichever occurs first. The cost of a distribution system in which 4.16-kv primary feeders are loaded to a maximum of 2,500 kva is compared with the cost of three different distribution systems for the same load density, employing 13.2-kv primary feeders, loaded to a maximum of 2,500, 5,000, or 7,500 kva. The actual load densities considered are 125, 250, 500, 1,000, 2,000, 4,000, 8,000, and 16,000 kva per square mile.

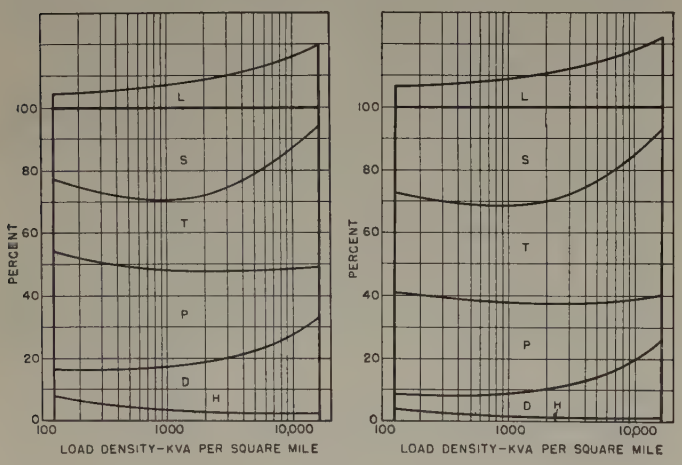

Figure 1 (left). Per cent of total distribution system cost allocated to each component, and capitalized losses. 4.16-kv primary feeder voltage. Maximum allowable primary-feeder loading of 2,500 kva. Figure 2 (right). Per cent of total distribution system cost allocated to each component, and capitalized losses. 13.2-kv primary-feeder voltage. Maximum allowable primary-feeder loading of 7,500 kva

H—Subtransmission circuits
D—Distribution substations
P—Primary-feeder circuits
T—Distribution transformers
S—Secondary circuits
L—Capitalized losses

The total distribution system cost is considered to be the sum of the costs for high-voltage subtransmission circuits, primary distribution substation, primary-feeder circuits distribution transformers, secondaries, and capitalized system losses. The per cent of total system cost allocated to each of these components is shown in Figure 1 for a system with 4.16-kv primary feeders loaded to a maximum of 2,500 kva, and in Figure 2 the total system cost for a system with 13.2-kv primary feeders loaded to a maximum of 7,500 kva.

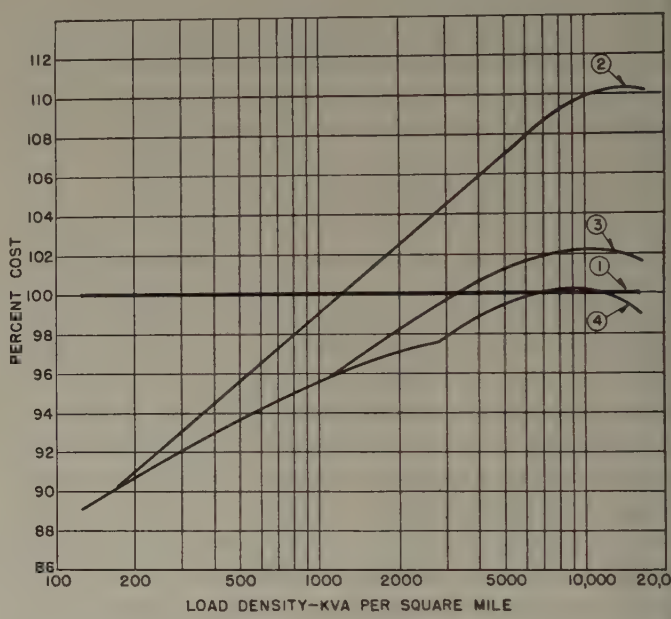

Figure 3. Comparative cost, with capitalized losses included, o alternative distribution systems employing either 4.16-kv o 13.2-kv primary-feeder voltage

(1) 4.16 kv, maximum allowable primary-feeder loading of 2,500 kva
(2) 13.2 kv, maximum allowable primary-feeder loading of 2,500 kva
(3) 13.2 kv, maximum allowable primary-feeder loading of 5,000 kva
(4) 13.2 kv, maximum allowable primary-feeder loading of 7,500 kva

In Figure 3, the comparative total costs for the fou systems indicate that in light-load-density areas, wher primary-feeder voltage drop is the factor that determine the allowable loading of primary feeders, 13.2 kv is eco nomically favorable. As a primary-feeder voltage, 4.1 kv becomes more favorable economically as load densit of the system increases, and as the kilovolt-ampere load ing limit of the alternative 13.2-kv primary feeders of th system is reduced.

Digest of paper 53-79, "Comparative Cost of Distribution Systems With 4.16-Kv 13.2-Kv Primary Feeders," recommended by the AIEE Committee on Transmissio and Distribution and approved by the AIEE Committee on Technical Operations f presentation at the AIEE Winter General Meeting, New York, N. Y., January 19–2 1953. Not scheduled for publication in AIEE *Transactions*.

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Insulation Co-ordination

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Certain changes in United States practice are proposed, while the practices in the United States and Canada are presented for the benefit of engineers of other countries.

THE CHOICE of equipment insulation is dependent upon the magnitude of voltage permitted by the protective equipment. In 1941, by joint action of AIEE, Edison Electric Institute (EEI), and National Electrical Manufacturers Association (NEMA), a list of basic impulse insulation levels was established from which all insulation levels were to be chosen. More recently this problem has been attacked anew, and on May 29, 1950, by joint action of these same organizations, agreement was obtained upon a set of values for insulation levels of 450 to 1,050 kv, inclusive. This action recognized the excellent operating experience obtained with reduced insulation on systems with good grounding conditions and to this end introduced a new level of 825 kv, intended for 230-kv systems with exceptionally good grounding. The work of the triple-joint committee is continuing for systems of lower voltage. International standardization, through the International Electrotechnical Commission, is also in progress. Because of the differences in system voltage in different countries, as well as the variation in emphasis placed on different operating practices, international standardization presents a more difficult problem.

It is the purpose of this article to present the opinions and methods of approach of one group of individuals working on this problem in the hope that this analysis will assist in the understanding of the problem and promote the cause of national and international standardization of insulation levels. Basic impulse insulation levels above 1,050 kv are not considered here since preferred system voltages have not been designated. The authors suggest, however, that the same philosophy of protection presented here be applied in establishing the higher levels.

LIGHTNING ARRESTERS

Types. In both the United States and Canada insulation co-ordination centers largely around the characteristics of lightning arresters. There are three classes of lightning arresters for the protection of apparatus: station, line, and distribution. Station and line arresters are of the valve type, whereas distribution arresters may be of the valve or expulsion type. All lightning arresters are rated in terms of 60- or 50-cycle voltage. The voltage rating designates the maximum rms voltage of system frequency, applied across the arrester terminals, against which it can interrupt its power follow current and restore itself to an insulator once discharged by a surge. Valve arresters have a voltage rating only, because they themselves determine their follow current. Expulsion arresters have, in addition, fault current ratings since their follow current may depend not only on the arrester, but on the system characteristics as well.

Characteristics. The protective characteristics of expulsion arresters are determined by their impulse sparkover voltages. The voltage during the flow of discharge current, called discharge or residual voltage, is low and need not be considered. In the case of valve arresters, the discharge voltage is the significant protective characteristic for purposes of co-ordination. The impulse sparkover voltage of valve arresters usually is less than the discharge voltage, and in addition, its duration is so short that it becomes unimportant.

The discharge voltages of arresters are stated in terms of the crest voltage reached during the discharge of an impulse current of 10×20-microsecond wave shape. The wave shape of the corresponding discharge voltage approximates the 1.5×40-microsecond waveform in terms of which the withstand voltage of insulation is specified. For station-type arresters, the maximum discharge voltage crests at 5,000, 10,000, and 20,000 amperes are approximately 3.67, 3.95, and 4.30 times the arrester rated rms voltage. Similarly, for the line-type arresters, the discharge voltages for 5,000, 10,000, and 20,000 amperes are, respectively, 4.68, 5.18, and 5.69 times the rated voltage. In this article, co-ordination is based on the discharge characteristics of station-type arresters. Other types of arresters may be used in practice; however, the differences in performance should be recognized.

Selection of Arrester Rating. In order to determine a protected level, not only must the impulse characteristics of arresters be known, but the rating of the arrester must be selected. The proper rating depends on the maximum system voltage and the system characteristics, especially the type of system grounding.

On systems where neutrals are isolated, it is customary to use arresters whose ratings are at least as high as the maximum operating phase-to-phase system voltage. These arresters generally are called 100-per-cent arresters.

On systems whose neutrals are grounded, there exist various possibilities of arrester ratings, depending on the system characteristics and the arrester location. Systems grounded through high impedance or Petersen coils require 100-per-cent arresters. On low-impedance grounded sys-

Condensed text of paper 52-278, "Insulation Co-ordination," recommended by the AIEE Committees on Substations and Transmission and Distribution and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, New Orleans, La., October 13–17, 1952. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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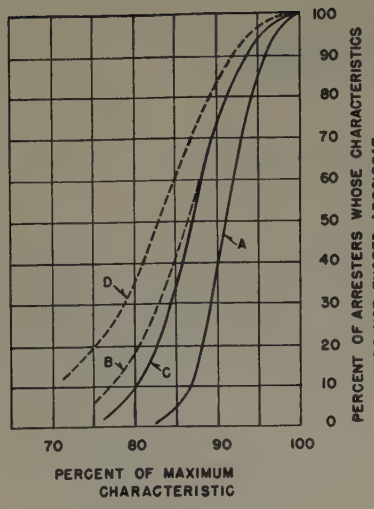


Figure 1. Probable distribution of protective characteristics of lightning arresters. These distributions are truncated, that is, limits are fixed. These curves do not apply to arresters for rotating machines. A. Station type, discharge voltage; B. Station type, impulse sparkover; C. Line type, discharge voltage; D. Line type, impulse sparkover

tems, lower arrester ratings may be satisfactory. When the maximum dynamic voltage to ground on any phase is limited to 80 per cent of the normal line-to-line voltage, a so-called 80-per-cent arrester is applicable. This is an arrester whose rating is 80 per cent, or the next higher standard rating, of the rating usually used on isolated neutral systems. If the system impedances are such that X_0/X_1 ratio is less than three and the R_0/X_1 ratio does not exceed one, then the maximum line-to-ground voltage that appears on any phase during fault conditions will not in general exceed 80 per cent. Such a system is usually referred to as being "effectively grounded." The large majority of systems in the United States operating at 115 kv or higher are effectively grounded.

Even lower rated arresters are sometimes applied. In each application the possible overvoltage must be calculated to minimize the possibility of arrester damage. Limits have not been generally agreed upon for X_0/X_1 and R_0/X_1 ratios for these lower rated applications.

The 4-wire distribution system, in which the neutral wire is carried to each transformer and grounded at least at each transformer, generally utilizes arresters 75 per cent or less, a practice developed largely from experience.

Where reduced-rating 80- or 75-per-cent arresters are applicable, the protective levels are lowered correspondingly, thereby affecting the co-ordination. In this article, applications will be referred to as 100, 80, or 75 per cent.

Station-type lightning arresters of modern construction are relied upon to a high degree in the design and operation of electric systems. They have excellent service records. When properly applied, the rate of damage to arresters is about one in 10,000. The rate of damage to station-type arresters has been decreasing considerably, not only because of improvements in their construction, but also because the major system causes of arrester damage are being eliminated. The rate of damage to line and distribution types of arresters is higher, probably because of their lower discharge capacity and possibly because the user may accept a greater risk in the application of these types. Some 20 years ago the record was not as good. The accumulation of moisture in arresters then contributed considerably to arrester damage. This is no longer a cause of concern.

PROTECTED LEVELS AND MARGINS

With the arrester rating determined for any pa ticular location, it is next necessary to set up th conditions under which the arrester will operate so tha the voltage to which the equipment will be exposed can b determined. Two general types of application are recog nized.

1. Substation protection.
2. Line equipment protection.

Substation Protection. Most transmission lines and sub stations, particularly for those above 69 kv, are protecte against lightning by means of ground wires. It has bee estimated, based upon records obtained by numerou investigations, that, for the discharges of arresters locate in stations, only 4 per cent exceed 5,000 amperes cres and only 1 per cent exceeds 10,000 amperes crest. Th probability of occurrence of these discharges for eac arrester is one every 14 years for 5,000 amperes and on every 58 years for 10,000 amperes. A reasonable compro mise for a single value of current to use in co-ordinatin applications for different systems thus would appear to b a 5,000-ampere 10×20-microsecond wave. Analytica considerations indicate that the discharge currents increas with system voltage. Similarly, the discharge currents fo wood-pole lines are, in general, higher than those on steel tower lines.

A margin must be assumed above the discharge voltag corresponding to 5,000 amperes to cover the many in tangible factors involved in this problem. For this purpose an allowance of 15 per cent of the arrester discharge voltag plus a constant of 30 kv will be taken. The constant o 30 kv is intended to cover the voltage drop in the arreste downlead and in the arrester ground. This will be as sumed to be independent of the system voltage. The 15 per-cent margin is based upon an estimate of the mos severe conditions to be encountered. A strong elemen of judgment, based upon operating experience to date, i involved in this assumption. Many of the factors enterin into the margin are of a probability nature and difficul of determination. It is improbable that all of the mos severe conditions will occur simultaneously; they shoul not be pyramided one upon the other. As will be see subsequently, the assumption of the 5,000-ampere 10×20 microsecond discharge current through the arrester plu the margin just enumerated results in a protected leve that conforms closely to the basic impulse insulation level which, in practice, have exhibited excellent performance.

To the extent outlined in the two steps just mentioned the assumptions made for the lightning arrester discharg current and the assumptions for the margins are interre lated. If more stringent discharge conditions be specifie for the lightning arresters, then still to demonstrate th same acceptable co-ordination, it would be necessary t use a smaller margin between the lightning arrester di charge voltage and the basic impulse insulation levels.

It is appreciated that the foregoing approach simplifie the problem enormously. An accurate analysis attemptin to take all the factors into proper accord would be ex tremely complicated, if not impossible. This is not to sa

that the various factors entering into the problem should not be studied individually.

Some of the factors entering into the foregoing assumptions are

1. *Wave shape of discharge current.* The wave shape of the arrester discharge current affects the crest amplitude and the wave shape of the discharge voltage. A rate of rise of 5,000 amperes per microsecond with a crest current of 5,000 amperes has been suggested by some as a more suitable discharge current upon which to base co-ordination. This would be a departure from a practice on which all our experience rests. There is no published evidence that a discharge current of this character has been obtained through an arrester in the field that has been connected to a transmission system supplied with a ground or shield wire. Such a wave is difficult of attainment in the laboratory. The authors do not favor this suggestion. Since so many factors are involved, it appears unwise to put too much emphasis on the 5,000-ampere-per-microsecond rate of rise which evidence from the field indicates does not occur frequently in shielded systems.

2. *Shielding.* It has been assumed that both the substation and the transmission line are protected by a ground wire. The absence of station and line shielding will increase the probability of high currents in the arresters. This is particularly true for the shielding over the station and the first few spans of line.

3. *Separation between the arrester and protected equipment.* It is desirable that the arrester be located as close as possible to vital equipment. In some cases, more than one arrester is required to assure protection of the substation. Such factors as the magnitude and the rate of rise of the incoming voltage waves, the length of the downleads to the transformer and to the arrester, the separation between the protected equipment and the downlead, the presence of additional outgoing lines, and the length of stub end busses; all affect the magnitude and wave shape of the voltage at the protected equipment.

4. *Insulation characteristic.* The major insulation of transformers is such that for chopped waves the withstand voltage is about 15 per cent greater than for the full-wave value. This turnup of the insulation value for short times can be regarded as a favorable tolerance, but must be considered simultaneously with the wave shapes obtained when separation factors are analyzed.

5. *Probability of lightning arrester manufacture.* In view of the probable distribution of discharge voltages shown in Figure 1, it has been proposed that co-ordination be based not on the maximum to be expected, but a lower arrester voltage. With this the authors do not agree, but believe that discharge voltages below the maximum should be regarded as an additional favorable tolerance included with the other factors entering into the margins. A similar objection applies to taking advantage of a possible lower arrester voltage characteristic arising from the fact that a large number of elements are used in series.

6. *Probability of manufacture of the protected equipment.* Although the insulation of the protected equipment is rated on a minimum basis, in the variabilities of manufacture and in the necessities of design, certain margins are involved. These margins exist with even more reason than the arrester margins, as the arrester probability can be controlled by test in the course of manufacture. There is no way of determining the actual insulation breakdown strength of solid insulation without destruction. The authors are not proposing that this region be encroached upon, but merely state that this region does exist and should be recognized.

From the foregoing it is quite evident that for usual applications it is quite impractical to approach the problem other than through an assumption such as indicated, namely, adopt a reasonable discharge current through the lightning arrester and a margin above the discharge voltage resulting with this current through the arrester.

Having decided to base the protected level on the

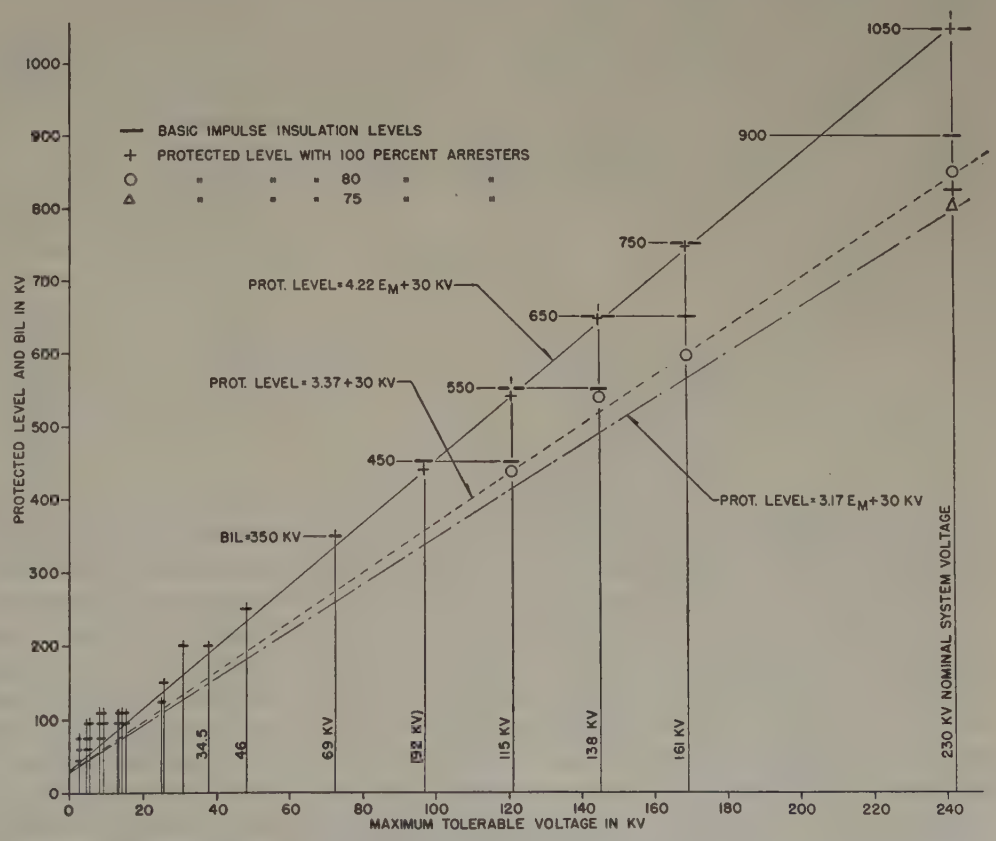
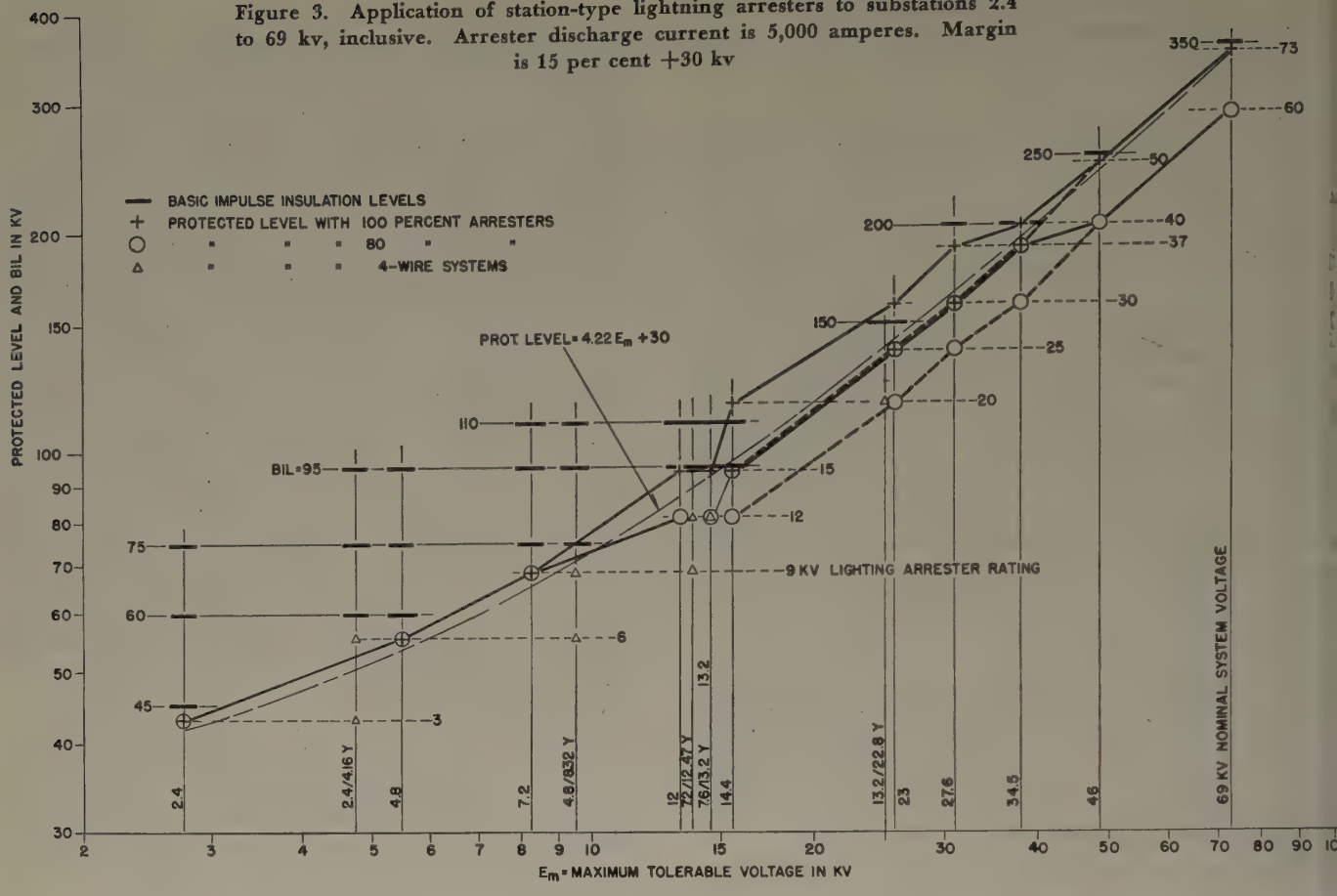


Figure 2. Application of station-type lightning arresters to substations 115 to 230 kv, inclusive. Arrester discharge current is 5,000 amperes, 10×20 wave. Margin is 15 per cent +30 kv

Figure 3. Application of station-type lightning arresters to substations 2.4 to 69 kv, inclusive. Arrester discharge current is 5,000 amperes. Margin is 15 per cent +30 kv



voltage of a station arrester when discharging a 5,000-ampere 10×20-microsecond current wave, with a margin of 15 per cent plus 30 kv, it is possible to arrive at an analytical expression for the protected level. The discharge voltage $= \frac{(P)}{100}(3.67)\ (E_m)$ where P is the arrester application in per cent and E_m is the maximum system voltage. Applying the margin, the protected level becomes:

$$(1.15)\frac{(P)}{100}(3.67)\,(E_m)+30$$

which reduces to

$4.22\ E_m+30$ kv for 100-per-cent applications (1)

$3.37\ E_m+30$ kv for 80-per-cent applications (2)

$3.17\ E_m+30$ kv for 75-per-cent applications (3)

Line Equipment Protection. This condition is to cover equipment connected directly to the line in exposed positions. It applies particularly to system voltages of 69 kv and below. Due to the greater exposure, the probability of high discharge currents is greater than in the case of substation applications. The maximum discharge voltage for a 20,000-ampere 10×20-microsecond wave will be used. In these cases, the lightning arresters and the clearances required are so small that the lightning arrester can be mounted directly on the equipment to be protected. For this reason, no margin for co-ordination purposes is necessary. This is not to say that many of the factors enumerated in the foregoing will not be present. The magnitude of the current discharged by the arreste may be larger or smaller than the assumed 20,000 ampere Likewise, the wave shape of the discharge current ma depart from the assumed 10×20-microsecond wave. the transformer is connected to a system which is shielde it is probable that the discharge current will be small than 20,000 amperes. The same probabilities relating the insulation characteristic, the probability of arreste manufacture and the probability of manufacture of th protected equipment, will apply to this case as for sul station protection. It is assumed that the departure fro the assumed characteristics is such that simultaneous o currence is not probable and that satisfactory protectio will be obtained with the assumed arrester discharg current and no margin.

PROTECTED LEVELS

The protected level of substation equipment usi station-type lightning arresters for the conditions ju enumerated is plotted in Figure 2. The straight lin show the protected level obtained according to equations 2, and 3. These formulas assume an infinitely lar number of arrester ratings from which to choose arreste The plotted points represent the protected levels obtain by using the next larger standard lightning arreste These points may be compared to the correspondi basic impulse insulation levels that are now standar Recognizing the admirable performance obtained with th type of arrester with the standard basic impulse insulati levels, the assumptions for arrester discharge current a

margins are fully justified. The abscissa for this figure is plotted against the maximum tolerable voltage which, for all system voltages in excess of 34.5 kv, is 5 per cent greater than the nominal system voltage.

Due to the difficulty in discerning the points in the lower range of voltages in Figure 2, Figure 3 has been prepared for this range. The analytical expression for 100-per-cent applications has been drawn for orientation. In the United States, in this range of system voltages, no attempt is made to economize on insulation because of grounding the system. This results because the disadvantages of a greater number of levels absorb such advantages that might result from introducing less material in the equipment. The crosses indicate the protected levels that can be attained with arresters. Between systems of 14.4 kv and 34.5 kv, two alternate arresters are used. In this range, with the higher rated arresters, the protected level of two systems lies above the corresponding basic impulse insulation levels. This is particularly pronounced for the lower level basic impulse insulation level in the 14.4-kv system. The protected level provided by the lower rated arresters in this range is well co-ordinated with the corresponding basic impulse insulation levels. However, these lower rated arresters in all cases have a rating just slightly below the maximum tolerable system voltages, and should not be applied unless it is known that the system voltage at the particular point of application is lower.

The advantage of the grounded neutral system is quite evident. It permits the use of a sufficiently low rated arrester so that protection is positive and at the same time the arrester is not endangered.

Of recent years the 13.2/22.8 Y system has come into considerable favor for pole-type rural distribution lines. While not widely recognized as a standard voltage, its use is growing rapidly. A basic impulse insulation level of 125 kv is regularly being supplied for distribution transformers.

The existence of the double and triple values of basic impulse insulation levels in the lower voltages will be discussed later. Let it suffice for the moment to observe that, except for the 14.4-kv system, the arresters as applied supply protection for the lowest level.

Similar data for line-type arresters are plotted in Figure 4. The same assumptions as to arrester rating, arrester discharge current, and margin were assumed. It is evident that the protection obtained, as compared to station-type arresters, is less. In many of these applications, to demonstrate protection at all, it is necessary to decrease the severity of the assumptions. This is particularly true of the 100-per-cent arrester applications.

Similar data for line equipment protection are plotted in Figure 5, using the assumptions for this case, namely a 20,000-ampere discharge through the arrester and no margin. Here also a comparison of the protected level with the insulation level would indicate incomplete protection where 100-per-cent arresters are applied. For systems of this type, the lower rated arresters are applied somewhat above their rating unless the system voltage is lower than the standard maximum tolerable value. The advantage of grounding, in permitting the use of lower

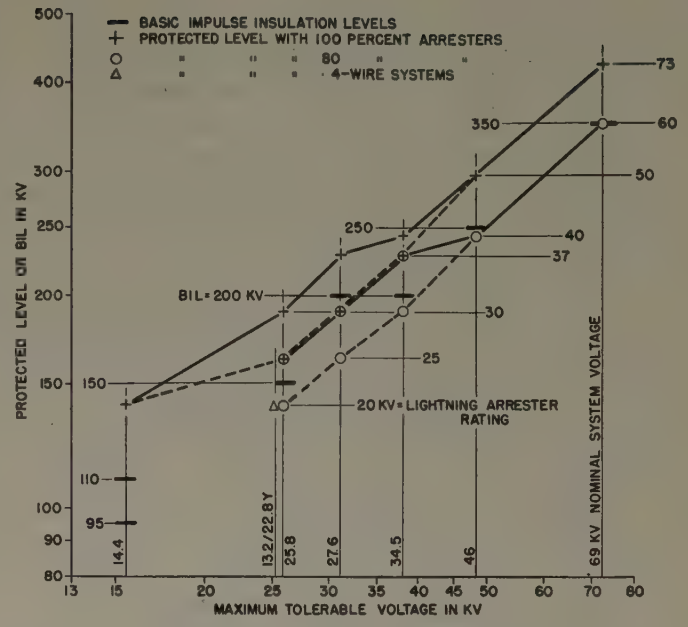


Figure 4. Application of line-type lightning arresters to substations 14.4 to 69 kv, inclusive. Arrester discharge current is 5,000 amperes. Margin is 15 per cent +30 kv

rated arresters, is well illustrated. To form an idea of the improvement in protected level for discharge currents below 20,000 amperes, the current scale has been added. By merely dropping any point by the distance shown on the arrester current scale, the protected level for a current other than 20,000 amperes can be obtained.

For system voltages of 14.4 kv and below, several important factors enter to complicate the problem of transformer protection. First, a distinction is made between distribution and power transformers. In distribution

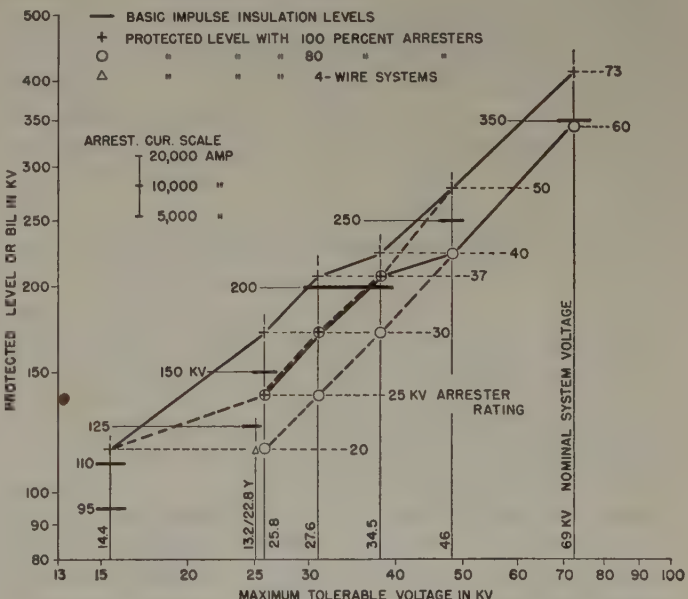


Figure 5. Application of line-type lightning arresters to line equipment protection. Plotted points for 20,000-ampere arrester discharge. No margin. For other currents drop points by distance indicated by arrester current scale. Dotted portion of curves are borderline applications and should not be used unless system voltage is lower than standard maximum tolerable

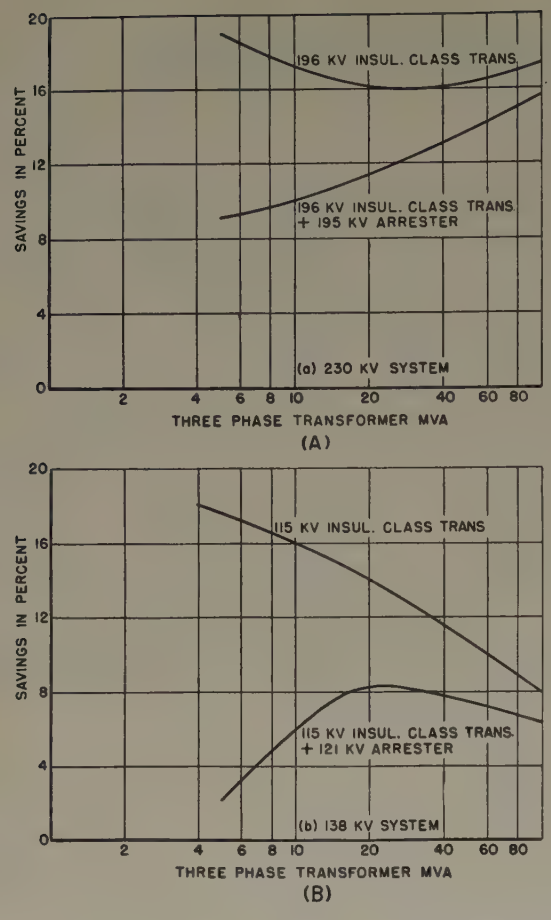


Figure 6. Typical savings in equipment cost resulting from the use of reduced transformer insulation. Savings are expressed in per cent of fully insulated transformer cost

transformers, 500 kva and below, the number of transformers being so large every effort is made to keep the insulation level as low as consistent with good protection. In the larger transformers, above 500 kva, the impulse levels are increased one level, although the low-frequency tests are kept the same. The added insulation is attractive to utility engineers on the grounds of conservatism, but little argument actually can be advanced to support this practice. If a given amount of insulation is already sufficient, added insulation is simply superfluous. Second, single-phase transformers whose terminal voltage is rated less than 8.67 kv are insulated so that they may be connected for either delta or Y operation with the same voltage across their terminals but with higher phase-to-phase voltage on the system. Third, since the limitations imposed by the second consideration do not apply to 3-phase transformers, there is a distinction as to whether the transformer is single- or 3-phase.

Basic Impulse Insulation Levels. The foregoing discussion was intended to analyze the impulse insulation levels in use in the United States in the light of present-day lightning arrester characteristics. It presents the justification for the United States values listed in Table I. In addition to those listed, a half-level of 825 kv has been approved by a joint committee of AIEE, EEI, and NEMA. An additional value of 125 kv has also found favor with some utilities for rural 4-wire systems, and while adequate protection can

Table I. Proposed International Electrotechnical Commissi Standard Impulse Insulation Levels in Kv

Series I	Series II, Standard in Use in th United States* and Cana
45	
60	
80	
100	
125	1
170	1
240	2
325	2
380	3
450†	
550	
650	
750	
900	
1,050	

* In addition, the United States' Standards also include a 30-kv value and a ten tively approved value of 825 kv.

† The figures in this column are common to both Series I and Series II.

be provided for this type of equipment, it has not receive approval as a standard level.

REDUCED INSULATION IN POWER TRANSFORMERS AND CIRCUIT BREAKERS

THE APPLICATION OF reduced transformer insulatio as practiced in most locations in the United States, predicated on the basis of having the best available pr tection against lightning surges, which implies, in additio to adequate shielding, the installation of 80-per-cent, lower, station-type lightning arresters on or close to th transformer. Typical savings in equipment cost that ca be realized by using reduced insulation are shown Figure 6*A* as a function of transformer rating. Th figure is based on the use of oil-insulated self-cooled 3-pha transformers on a 230-kv solidly grounded 60-cycle syste Reducing the transformer insulation one class, from 23 to 196 kv, results in savings of 9 to 15 per cent, includin the cost of station-type arresters. The savings in tran former cost alone exceed 16 per cent. The cost of a ful insulation class transformer without lightning arrester taken as 100 per cent. Approximately the same savin can be realized for forced-oil water-cooled transforme as for self-cooled transformers.

At the lower transmission voltages the savings, althoug still significant, are not as large as at the higher voltag because insulation represents a smaller part of the tot transformer cost. As shown in Figure 6*B*, the savings rang between 2 and 8 per cent for the case of 115-kv insulatio class transformers and 121-kv station-type arresters applie to a 138-kv system.

It should be noted that the lower curves in Figure 6 and *B* assume that arresters are used with the reduce insulation transformers, but not with the transforme employing full insulation. This rather unfavorable com parison shows that important savings can be realized b using lightning arresters and reduced insulation. Th use of reduced transformer insulation without lightnin arresters is not considered good engineering practice most locations.

In the United States, the use of reduced insulation

transformers is predicated on using 80- or 75-per-cent station-type lightning arresters. To the best knowledge of the authors, rod gaps are not used as the primary protection of transformers employing reduced insulation. The definite trend toward reduced insulation at the higher voltages will decrease the use of rod gaps for the primary protection of transformers. As shown in Figure 6*A* and *B*, lower equipment costs result with reduced insulation transformers and lightning arresters as compared to full insulation and no arresters. This is fortunate because better protection is provided and fewer outages result even with lower equipment costs.

The economies that can be realized by reducing the insulation in high-voltage circuit breakers are less than in the case of power transformers. An estimate of the savings that might be made by reducing the insulation class of circuit breakers one class indicated possible savings on the order of 12 per cent at 230 kv. The cost of lightning arresters will exceed the savings that could be realized by reducing the circuit breaker insulation for all voltages below 230 kv, which means that reduced insulation cannot be justified simply by the application of separate arresters for circuit breaker protection.

Circuit breakers, in many cases, are installed at locations subjected to the more severe surges arriving in a station. It should be noted, too, that the more common practice in the United States is to locate lightning arresters close to power transformers, which introduces considerable separation distance between the arresters and the line circuit breakers. The installation of separate arresters for the protection of circuit breakers is a practice that is not followed in the United States, excepting at the lower system voltages and in special cases at the higher voltages.

The foregoing factors limit the application of reduced-insulation circuit breakers to systems operating at voltages of 230 kv, and above, where the economies are appreciable and the separation distances, between arresters and the protected equipment, are of less importance. Many 196-kv class circuit breakers are in service on 230-kv systems.

CONCLUSIONS AND RECOMMENDATIONS

1. In the protection of substations, particular attention should be given to the shielding of the conductors against direct strokes of lightning. This may be accomplished by the erection of poles, where adjacent structures do not provide shielding, or by extending the ground wires from the transmission line over the substation.

2. Special attention should be given to the reduction of the tower footing resistances of the towers adjacent to a substation.

3. For substation application, the use of a margin of at least 15 per cent plus 30 kv between the maximum lightning arrester characteristic, for a 5,000-ampere 10×20-microsecond wave, and the basic impulse insulation level of the protected equipment is recommended. This recommendation is based upon surge protection considerations. In some cases other factors may dictate the minimum insulation requirements.

4. Where equipment is located out along the line and is protected by an arrester mounted on the equipment, the use of the maximum lightning arrester characteristic for a 20,000-ampere 10×20-microsecond wave, with no margin, is recommended.

5. It is recommended that the characteristics of lightning arresters of the valve type be specified by indicating the *maximum* discharge voltage for a 10×20-microsecond wave and that the probability of manufacture of arresters of lower characteristics be given in the form of a curve, rather than by specifying, as at present, the *average* discharge voltage and a positive tolerance of 10 or 15 per cent, according to whether the arrester is of the station or line type.

6. On hydroelectric systems, consideration should be given to the possibility of high voltage caused by overspeed following load rejection. In general, it is believed that this may be neglected because the probability of a lightning stroke during the overspeed is remote.

7. It has been demonstrated by experience and analysis that rod-gap protection is definitely inferior to that provided by lightning arresters. In some applications the use of arresters may result in a lower total investment in station equipment by permitting the use of lower insulation levels.

8. Full insulation is indicated for circuit breakers of all voltage classes below 230 kv since separation distances between breakers and lightning arresters are normally greater than in the case of transformers. Further, the savings realized by reduced insulation are not as large in the case of circuit breakers as in the case of transformers.

9. Recognizing the practical difficulties of the following suggestion, still it is recommended that some consideration be given to the reduction in the number of recognized system voltages in the range of 12.0 kv to 14.4 kv, inclusive.

10. It is recommended that the impulse test values for transformers above 500 kva, intended for systems having voltages 15 kv and below, be made equal to the impulse test values for transformers below 500 kva. In other words, this means that the impulse test values for power transformers in this range be made equal to the impulse test values for distribution transformers.

Isotopes in Power Plants

Atomic energy, in isotope form, is doing a practical and important job for the power industry in inspecting boilers and lines in steam plants and in radiographic inspection of welded seams in steam boilers. Isotope Products, Ltd., using Iridium 192, have taken radiographic pictures on operating boilers. Recently, Isotope Products have been inspecting cast sections of a turbine speed ring for a hydroelectric generating section.

Other applications of isotopes' penetrating photographic properties include examination of power transmission units such as insulators, cable joints, and pothead castings.

Thus, both in the steam generating units and in the transmission equipment which carries off the electric energy, isotope gamma-ray radiography is doing an important inspection job.

Hydraulic Servos With Hydraulic-Amplifier Value

R. L. SCRAFFORD
ASSOCIATE MEMBER AIEE

ELECTROHYDRAULIC SYSTEMS HAVE certain advantages over pure electromechanical systems which make them particularly suitable as an adjunct to electronic control for high-power-level actuation. Performance of a typical hydraulic servomechanism utilizing the Cornell Aeronautical Laboratories (CAL) transfer valve is illustrated in Figure 1.

All servomechanisms may be divided into two parts: (*a*) intelligence section which includes voltage-amplifying and phase-compensating functions, and (*b*) power output and driver stages. Section *a* contains devices which perform the various signaling and computing functions. They provide no power to the load and may accomplish intelligence transmission by means of any of the systems used by communications and telemetering engineers. Section *b* contains the power-converting devices, in which power from some energy source is transferred to the load in response to a signal from the intelligence portion of the loop.

All mechanical servomechanisms are required to accomplish some motion at the output in response to a variable at the input. This motion will be opposed, as are all mechanical movements, by the three roots of force, namely, the act of doing work, acceleration of the structure, and mechanical friction. The frequency response of the servomechanism is determined mainly by the second of these which is brought about by the mass of the structure. This mass is dictated by factors of allowable deflection for a given load, and safety factor.

Often, in electric positioning servomechanisms, the designer will find that the inertia of the load is a small fraction of the total inertia which includes that of the actuator. This is aggravated by the fact that electric motors are essentially high-speed devices usually geared down to the load. At the motor end of this gear train, then, there is the large inertia which must accelerate very rapidly.

In the low-inertia hydraulic servomechanisms, the picture is entirely different. The actuator may be conveniently designed for a wide range of speeds or for linear o rotational motion.

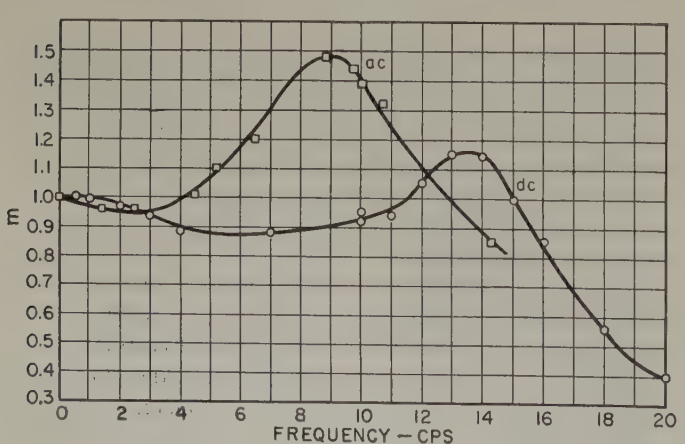


Figure 1. Closed loop characteristics

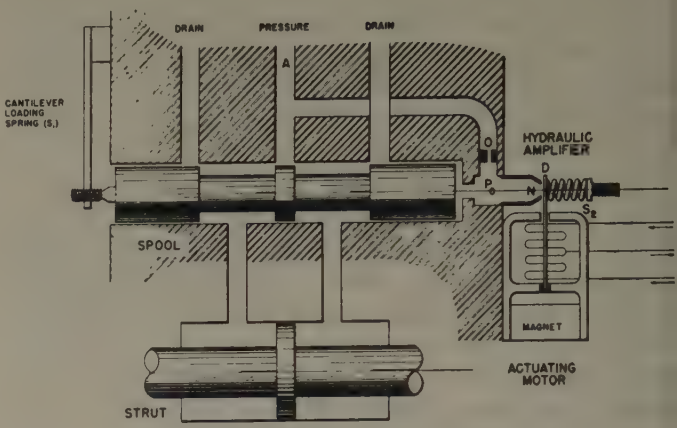


Figure 2. Valve schematic

The CAL d-c transfer valve, which falls in the categor of a linear power amplifier, can be driven to full outpu flow rate of 30 cubic inches per second at pressures of 1,50 to 2,000 pounds per square inch with an electric signal o the order of 20 milliwatts into one side of its center-tappe input impedance of 6,000 ohms. The time constant of th valve is on the order of 3 milliseconds. The a-c model re quires greater driving power.

The CAL transfer valve is shown schematically in Fig ure 2. Hydraulic pressure is applied at *A*. There is very small amount of hydraulic flow past the orifice *O*, int the chamber P_c, and out the nozzle *N*. Control of o flow through the nozzle is by the flapper *D*, actuated by a electric device. Pressure drop along this path is share between the orifice and the nozzle. Chamber pressure i then 750 pounds per square inch and the centering sprin may be adjusted to give zero flow.

Now, if a signal is applied to the coils of the electric ac tuator, the flapper will move in or out, either increasing o decreasing the nozzle pressure drop and, hence, the chambe pressure. An increase in chamber pressure results in th valve spool being moved to the left against the spring until new force balance is obtained. A decrease in chamber ha the opposite effect. The result is linear control of th flow of oil. Nozzle flow is small and kept inside the unit.

Although the advantages of hydraulic control have bee recognized and applied in the aircraft industry, there hav been few applications in the field of industrial contro It is the belief of the author that hydraulic systems inco porating this valve would result in superior solutions t problems in many instances.

Digest of paper 53-103, "Hydraulic Servos Incorporating a High-Speed Hydrauli Amplifier-Actuated Valve," recommended by the AIEE Committee on Feedback Co trol Systems and approved by the AIEE Committee on Technical Operations for prese tation at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 195 Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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Nuclear Power Plant Control Considerations

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The general considerations affecting nuclear power plant control-system design are reviewed. Special emphasis is placed on the features of reactor control.

THE DEVELOPMENT procedure for designing the control system for a nuclear power plant is basically the same procedure as for any other type of power plant. However, the presence of a nuclear reactor as a component in the system imposes many unusual design problems. The basic method of approach to control-system design consists first of studying the plant operational and control requirements. Following this review a preliminary block diagram of a control system to fulfill these requirements may be attempted. However, after a study of this diagram, it often becomes apparent that the inherent dynamics of the plant and the characteristics and limitations of some of its components are of utmost importance. Modifications are then made to the proposed block diagram. Once the desired operation of the control system is fully understood, the problem of synthesizing the control system can begin.

At the present state of the art, the problems introduced by the reactor necessitate more study than do the conventional ones. Considerable literature has been written about reactor control,[1–4] but very little is available on the control of power plants employing a reactor.

PLANT OPERATIONAL REQUIREMENTS

CERTAIN INFORMATION must be known concerning the operation and output of the plant. These operational requirements are usually given in the basic plant specification.

For the sake of illustration an elementary block diagram of a possible nuclear power plant is shown in Figure 1. Here the reactor is considered merely as a source of heat energy. When this heat is extracted by passing a coolant through the reactor, the heat energy is then transferred via a heat exchanger to a turbine system, and the output shaft of the turbine can be made to drive many types of working apparatus. The primary coolant considerations are basic for control design, and it may be mentioned in passing that gas, water, and liquid metals have been proposed as reactor coolants.

The ultimate usage of the system of course determines the specified-output requirements. A useful principle of control design is to attempt to place the primary operating controller near the output of the system. Consequently, the characteristics of the output loading as a function of turbine horsepower output is of first interest. In the case of an aircraft power plant this information might be specified in terms of aircraft speed as a function of turbine output. For a shipboard plant the information might be supplied in the form of propeller revolutions per minute versus turbine output. In any case an understanding of the relationship between the turbine and the load output is necessary to plant control.

Another factor affecting the type of control system is the operational transitions required. These transitions determine the range of control and the output-level variations required. Minor consideration is given to whether the final output is to be continuously variable, variable in steps, or some combination of the two.

Startup and shutdown requirements affect the control system. Here the nuclear reactor plays a prominent part in determining plant performance, for nuclear reactors cannot be started up too fast and never can be really shut down. In considering the output of the nuclear reactor, there is no such thing as "zero power" involved. Even in a new cold clean reactor which has been shut down as much as possible, an inherent source of neutrons exists which causes a certain amount of nuclear fission to occur. This fission produces minute amounts of power and in the process more neutrons are released. This effect requires

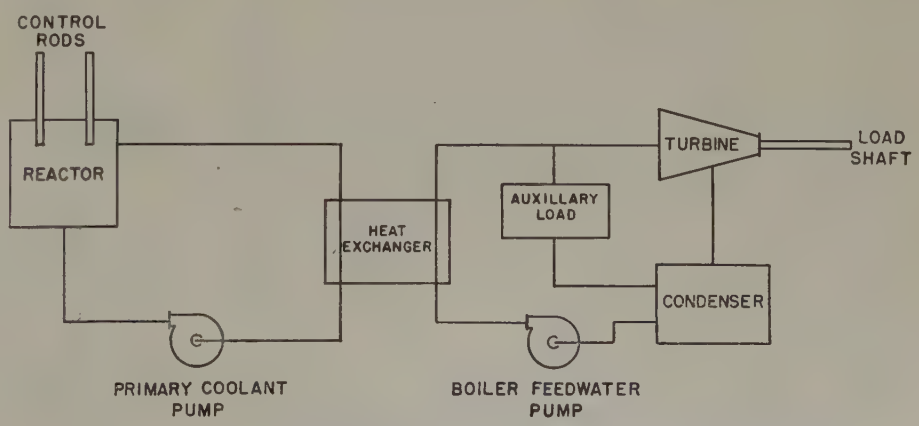

Figure 1. Elementary block diagram of possible nuclear power plant

Essentially full text of paper 53-51, "Nuclear Power Plant Control Considerations," recommended by the AIEE Committee on Instruments and Measuremets and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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Acknowledgment is made of the assistance rendered by J. C. Simons, J. N. Grace, and G. H. Conley of the Atomic Power Division, Westinghouse Electric Corporation.

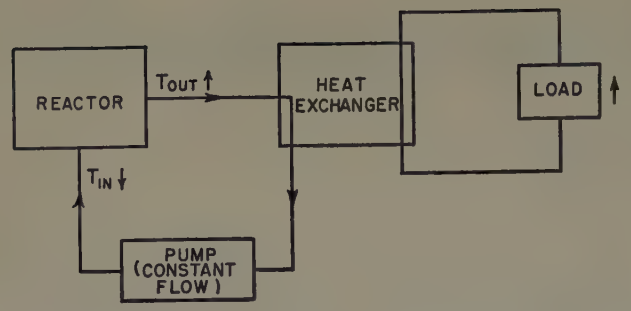

Figure 2. Simplified power-plant block diagram with reactor having a negative temperature coefficient

that the reactor neutron output be monitored continually to see that the neutron level is kept under control. In practical cases this monitoring means that instrumentation for measuring neutrons must be capable of operating over ranges as wide as 6 to 10 decades and control provisions must be provided over a similar range. Starting up a reactor from a cold condition means that the reactor can operate over a neutron range of many decades before any appreciable useful power begins to occur at the output. Some arbitrary number of neutron fissions has to be taken as zero power. For example, 1 per cent of full-load output might be considered to be the equivalent of zero power. Transitions between 1 per cent and 100 per cent full power can be made relatively rapidly, but because of the safety aspects involved, transitions from a cold startup must be made quite slowly.

A reactor which has been operating at a high power level is turned off neutronwise by manipulating the reactor control rods to reduce the reactivity of the reactor. However, many secondary radiations, particularly gamma rays, exist from the formed fission products. The amount of power from these secondary radiations is in some instances very substantial. Consequently, although the reactor has been turned off to the best of the ability of the operator, serious amounts of power still may be given off for a considerable length of time. Controlwise, this condition means auxiliary devices may be necessary to dump this spare power into a useless load. It can be seen therefore that the startup and shutdown of a nuclear power plant is dependent upon the reactor characteristics and differs from conventional plant techniques.

The transient output requirements of the plant are also of some importance. From an operational point of view certain peak demands will be made on the system. These demands are similar to those made on a conventional plant whereby above-rating performance can be obtained for short intervals of time. The operational probability of such demands and the operational probability of any preferential power level of operation must be analyzed. For example in a central station plant where a relatively fixed load can be made to exist, it might be desirable to operate the nuclear powered generator at 100-per-cent capacity during most of its lifetime. If this were the case, the plant control system might be optimized at this load value.

The design of the reactor with respect to poison override is another important operational-control consideration. When some types of reactors are shut down, nuclear poisons are known to build up and reduce the over-all reactivity of the reactor. In time these poisons ultimately die away. A certain amount of additional reactivity can be designed into a reactor to override this poisoning effect. The amount of the poisoning override which is built into the reactor becomes an operational factor because, with only a small amount of override reactivity in the system, the poisons can build up in a given amount of time to an amount capable of making the reactor inoperative. Before this time is reached the reactor might be turned back on and the poisons effectively burned out. If, however, the reactor poisons have built up to such a level that the plant cannot be turned on, it then becomes necessary to wait until the poisons die down to where the reactor again can be made critical. To build enough reactivity into a reactor always to override the poisons may require a large amount of fissionable material. If the service to which the power plant is put is such that the plant must be shut down frequently for critical periods then some other means must be found for supplying auxiliary power during the dead-off time of the reactor.

Another of the factors which is involved in the design of control components is the reactor and plant lifetime. Contrary to popular opinion, reactors do not have an indefinite life. The uranium atoms which are involved in the fission process become used up and although a tremendous amount of energy is available each time a uranium atom is fissioned, ultimately enough fissions occur so that the reactor becomes depleted in uranium and no longer will maintain a chain reaction. Other factors, such as radiation damage to the structural material of the reactor or the corrosion of any portion of the mechanisms, may cause the end of life of the reactor. If the design of the plant can be made such that all components have an effective indefinite lifetime compared with the lifetime of the reactor, it then may be feasible to employ some means of changing the fuel or of possibly even changing reactors.

PLANT CONTROL REQUIREMENTS

Once the over-all characteristics required of the plant have been specified, certain of the details of these characteristics pertaining directly to the control system can be examined. Detailed control information is needed about the steady-state output error that can be tolerated. That is, how important is it that the plant give

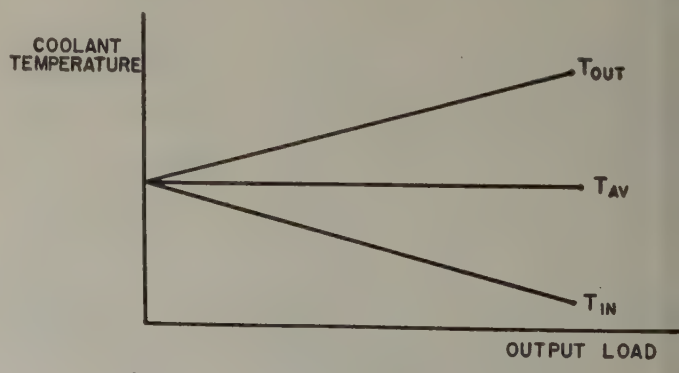

Figure 3. Steady-state temperature pattern

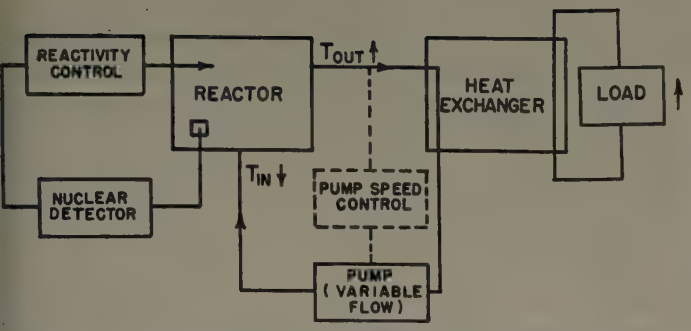

Figure 4. Block diagram of system maintaining primary coolant outlet temperature constant

put a fixed number of kilowatts or given propeller revolutions per minute and hold this output regardless of operational transients. The steady-state output error directly specifies the tolerable steady-state plant-instrument errors. Frequently, control systems are devised whereby the errors of many instruments in many loops add up to produce a higher probable error than the over-all specifications permit. On the other hand it is possible in the design of certain loops to integrate out instrument errors in such a manner that they do not show up in the final output. From the over-all error permitted, the designer can work backwards through each loop figuring the steady-state error that conventional control components will impose upon the system.

Similarly, certain plant and reactor transient errors may be permitted for some of the instruments. For example, if two thermometers are used in the system and one thermometer has a much larger time constant than the other, it is obvious that in a transient change both of these thermometers will not read identically. If these instruments are used in control loops, the output of a particular loop may temporarily permit an error to exist in the plant output.

One control requirement which is peculiar to the nuclear power plant is the instrumentation setup for alarm, cutback, and "scramming" circuits. Alarm circuits are common in the power industry, but the peculiar notion of "scram" is one limited to the reactor field. A scram in reactor parlance consists of an attempt to insert as much negative reactivity as possible into the reactor in as short a time as possible. Practically, a scram usually means injecting safety rods into the reactor with some violence. The safety requirements of the reactor are such that it is usually necessary to employ scramming devices. However, from a practical power point of view, it is obvious that the plant must be kept in an operable state as continuously as possible. The plant must not be shut off every time some minor control in a secondary loop malfunctions. Therefore the control designer's problem is to limit the number of controls which can cause a scram to an absolute minimum.

For all accidents other than the type requiring a scram, it is possible to cut back the reactor power level or merely to ring an alarm and have an operator manually make the necessary adjustment or shutdown.

THE HEART OF the control-system problem is the primary coolant-system operating cycle. There are many patterns into which the temperature and the flow of the coolant coming in and out of the reactor may be manipulated to produce the desired output power. The system operating cycle may be determined by many items such as auxiliary requirements, corrosion, or peak temperatures permitted. However, in a control system designed about a reactor one should attempt to follow this basic premise. *If the reactor has a negative temperature coefficient, the reactor system preferably should have the average coolant temperature constant.* A word of definition is necessary concerning the reactor temperature coefficient. To say that a reactor possesses a negative temperature coefficient means that as the reactor average temperature increases its over-all reactivity decreases. That is, the chain reaction will slow down with increasing temperature. This condition is obviously desirable.

Examine the simple plant shown in Figure 2 in the light of this premise. This illustration shows a primary coolant being circulated at constant flow through a reactor having a negative temperature coefficient. A steady output is being produced, and now suppose that more output is required by the load. This greater loading causes more heat to be extracted from the heat exchanger and for a short period of time the heat capacity of the heat exchanger can usually supply this load. However, the additional energy extracted from the system requires that the temperature of the coolant into the reactor must drop. If the reactor has a negative temperature coefficient as defined in the foregoing, the dropping of the coolant temperature inserts more reactivity into the reactor. If the reactor was initially in a critical state it now temporarily becomes supercritical. More energy is then available from the reactor, and consequently the output temperature of the coolant rises, and in the steady state the reactor returns to its critical condition with the average coolant temperature the same as it was initially. These steady-state temperature conditions are shown in Figure 3. It will be noted that without any control mechanism whatever the reactor system has stabilized itself about a given average temperature and automatically supplied any reasonable demand put upon it. This is the case only where the program of

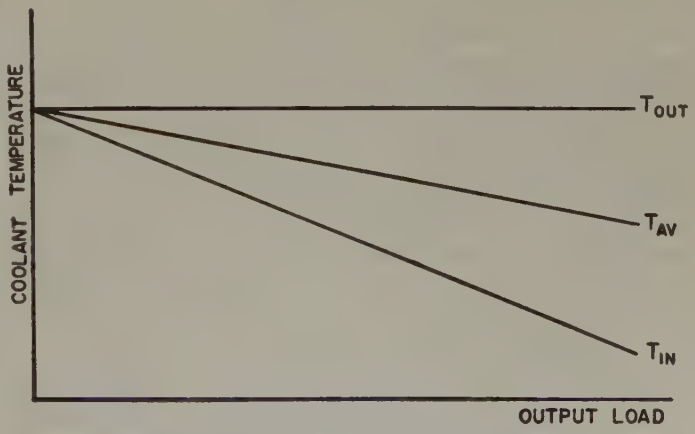

Figure 5. Steady-state temperature pattern

primary coolant operation is such that the average coolant temperature remains constant.

Let us assume now for some reason other than the reactor control system it is desirable to establish a different pattern of coolant temperatures. A reasonable pattern might be that shown in Figure 4. This illustration shows a simple system which might be called for by some structural condition desiring to keep the outlet temperature fixed at a given maximum level. Figure 5 shows a block diagram of how this condition might be achieved. Again if more load were required the inlet temperature to the reactor would drop. More reactivity would be inserted in the reactor because of the negative temperature coefficient. The outlet coolant temperature would tend to rise, but now a control has been inserted on the outlet temperature which measures the temperature and then varies the coolant pump speed in such a manner so as to reduce this outlet temperature. In this manner it is very feasible to hold the outlet temperature constant as a function of load as seen in Figure 4. However, it will be noted that the average coolant temperature drops with load meaning that the reactor, because of its negative temperature coefficient, would tend to operate in a supercritical condition. Consequently another control loop, usually rod control, must be added to the system to extract the reactivity put in by the change in coolant temperature.

The system of Figure 5, from a control point of view, compares unfavorably with the previous system. Here the external control systems which have been added cause the reactor system to operate in a manner contrary to its own inherent stability. Consequently, the system is not quite as safe and requires considerably more control equipment. Neither of the simple systems described is completely practical for an actual plant, but many derivatives and variations can be derived which will fulfill the required specifications in a compromise manner.

Once the primary system operating program has been determined, it would be very desirable to have the transfer functions of all of the major system components available. Unfortunately, in the present state of the art the control designer must be satisfied with far less. Usually a simplified approximation to the transfer function of a given component is made analytically, and the simplification is usually so great that the resulting equations can be handled easily in multiloop analogue networks.

Still more information, however, is needed before the designer can attempt to synthesize a complete control system. The transport times of the various coolants and the various loops must be known. Plants can be laid out with many feet of pipe between major components, and the time delay in these pipes is an important part of the control system. Of particular need is the total coolant circulating time, the time the primary coolant is in the reactor, the time the primary coolant is in the heat exchanger, and the time the primary coolant is in the pipes.

MISCELLANEOUS PLANT INFORMATION

There are many miscellaneous bits of information which also must be considered before the control system can be synthesized. Some of these factors depend upon the type of main coolant system used. For example in systems employing water or gas as the coolant, it usually will be found necessary to pressurize the main coolant system in order to obtain reasonable plant efficiency. Operating a loop under pressure calls for a complete pressurizing system including heaters and controls. These controls of necessity tie in with the controls of the main coolant system.

Another auxiliary system which directly affects the main system is provision of devices to take care of emergency electric-power failures. It may be desirable in some plants to provide auxiliary means of dumping power or employing elaborate fail-safe mechanisms.

A third item which affects the design is the type of coolant control permitted. If pumps or blowers are used to circulate the primary coolant, multiple-unit operation may be considered. Multispeed units, variable-speed units, or the switching of units on or off the line, are methods whereby coolant control may be achieved. One scheme may have a considerable advantage over another in a particular plant design.

Another factor is the auxiliary load which the plant must supply in addition to its primary output. In a nuclear power plant for a vessel, for example, a considerable hotel load exists separate from the prime task of driving propellers. It may be desirable also that most of the direct auxiliaries such as the pumps be tied to the nuclear powered system.

The foregoing statement implies that a certain percentage of the auxiliary load must be furnished from a source other than the nuclear power plant. Just as the battery on an automobile is required to run certain of the automobile's auxiliaries, a given amount of nonnuclear power is usually necessary to start the plant and keep it in operation. To start the plant and its auxiliaries and to maintain them under given operating conditions usually will require a large amount of detailed electric switchgear. This apparatus, though complicated in its own right, is conventional in nature and usually is capable of supplying exactly what the control-system designer wants.

When all of these factors have been considered, the control-system designer then can synthesize the entire system. The problems of the designer now involve problems of components, particularly the limitations of the various components. These limitations usually lead to the separate protection circuits for each of the major components.

COMPONENT CHARACTERISTICS AND LIMITATIONS

Components such as the turbine, the heat exchanger, the reactor vessel, the pumps, and the reactor itself require the most study. As each plant will contain a different group of components with different limitations only a few of the more obvious conventional characteristics and limitations of the plant will be mentioned in order that more emphasis may be placed on the reactor characteristics.

Of interest to the control designer are the heat-exchanger temperature limitations. The structural limitations of the heat exchanger probably will permit only certain

rates of change of temperature during both startup and shutdown operations. In other words, a heat exchanger may have a limitation stresswise such that the temperature of the coolant flowing through it may be permitted to change only by so many degrees per minute. A completely different rating, however, may be given the boiler for very short time transients. The same condition exists with respect to the reactor container. This container also will have stress limitations which will prevent any attempt to change coolant temperatures faster than a given rate.

Minor component limitations exist in the piping and the specific instrumentation of each component. Consideration of these limitations usually leads to the settings on the relief valves.

REACTOR NUCLEAR CHARACTERISTICS

IT NOW IS NECESSARY to examine roughly the various factors contained within the reactor itself which affect the over-all plant control. It has been shown[2] for control purposes that the reactor can be considered as a nonlinear device having an approximate transfer function of the form

$$K_r G_r(s) = \frac{K_r N_0}{s+a} \qquad (1)$$

where: K_r and a are constants, s is the LaPlace transform operator, and N_0 is the neutron level at which the reactor is operating.

The problem of controlling a loop containing this component whose gain depends upon the level at which it operates has been given extensive study.[2,3] The ultimate objective of this study was to be able to specify components of a control system which would manipulate the nuclear control rods. In practice the nuclear characteristics of the reactor also are involved in the detailed rod-moving-mechanism design.

To the component designer the problem of rod-mechanism design is a simple one of merely asking how far a given control rod must move and how rapidly. These questions can be answered by the reactor designer who must determine first the total number of control rods required and where they are placed in the reactor. These answers are derived from heat-transfer considerations. He then must consider the problem of the effectiveness of these rods in changing the over-all reactivity of the reactor. He also must consider how this effectiveness changes during the lifetime of the reactor. The variation of these constants with time brings up for consideration again the kinetic relationships of the various poison build-ups and burn-outs in the reactor. Reactor fuel depletion must be considered again and the total amount of reactivity to be built into the reactor determined.

The next reactor consideration is that of the magnitudes of the various coefficients of reactivity. The temperature coefficient of reactivity has been mentioned previously and its absolute magnitude is necessary to enable the determination of the degree of stability of the primary loop. Another coefficient of reactivity may be determined for some reactors and this is a pressure coefficient. This term is defined in a manner similar to the temperature coefficient and consists of the amount the reactivity of the reactor changes, and in what direction, as the pressure of the coolant in the reactor changes.

Another nuclear constant of importance to the control designer is the so-called "mean neutron lifetime." This is the average time taken by a neutron in starting out at birth in fission and dying by creating another fission or being absorbed or lost in some other portion of the reactor. The importance of the mean neutron lifetime controlwise comes about in that it affects the constant a of equation 1.

Startup and shutdown reactor considerations call for knowing the amount of nonneutron power produced immediately after shutdown and the neutron level to which the reactor ultimately will drop after a prolonged shutdown. This information plus the information concerning the artificial source of neutrons placed in the reactor is necessary for proper nuclear instrument design. The nuclear instrument design considers these facts, the known instrument sensitivities, the neutron and gamma flux levels about the reactor, and the type of instrumentation philosophy required. This information is then filtered into the control system and the placement of the instruments and their operation in the control system determined.

CONCLUSION

MANY OF THE FACTORS INVOLVED in the control of a nuclear power plant have been mentioned and it is apparent that the operational requirements of the plant determine the control system in the same manner as in a conventional plant. It has been noted that the fact that a reactor is present in the system does not alter any of the conventional requirements. Rather it appears as though a given performance can be specified for the nuclear plant, and the reactor and all of its appurtenances can be tailored to fit the required output.

REFERENCES

1. Instrumentation and Control of Reactors, **J. D. Trimmer, W. H. Jordan.** *Nucleonics* (New York, N. Y.), volume 9, number 4, 1951, page 60.

2. Automatic Control of Power Reactors, **M. A. Schultz.** Atomic Energy Commission Document *3163*, 1950.

3. Controlling a Power-Producing Nuclear Reactor, **J. M. Harrer.** *Nucleonics* (New York, N. Y.), volume 6, number 3, 1950, page 58.

4. Derivation and Integration of the Pile-Kinetic Equations, **H. Hurwitz, Jr.** *Nucleonics* (New York, N. Y.), volume 5, number 1, 1949, page 61.

Supercharged Steam Turbine-Generator

The first completely supercharged steam turbine-generator, now under construction at the Allis-Chalmers Manufacturing Company, is the latest and most important step in the history of size reduction of steam turbine-generators following the first use of supercharged cooling in the rotor of a 60,000-kw Allis-Chalmers generator installed in mid-1951.

In this design, cooled hydrogen is forced at high velocities through the conductors of both stator and rotor. The machine is being built for development and test purposes and will have a nominal rating of 40,000 kw and a 60,000-kw rating at increased hydrogen pressure.

Flashing of D-C Machines Caused by Short Circuits

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STUDIES MADE ON THE flashover characteristics of two d-c machines revealed in part the mechanism of flashover as a result of short circuits. Experimental data obtained from oscillographic records and from high-speed motion pictures substantiated the concepts of arcing currents and flashing currents as follows:

1. Arcing current is related to commutation and produces ions over the surface of the commutator.
2. Flashing current is in the opposite direction to arcing current.
3. Flashing results from the ionized film of gas that envelopes the commutator and is initiated where the brush-to-commutator voltage is high enough to sustain an arc with the ionized gases present.

The minimum time for flashing to occur after the initiation of a severe overload was found to be dependent upon the time required for a commutator segment to move from a brush of one polarity to the next brush of opposite polarity. Considerable randomness in time occurred for less severe conditions of flashing as shown in Figure 1.

The effect of operating conditions prior to short circuit were also determined. It was found that increasing the initial load increases the tendency of a generator to flash, or to be more specific, requires a reduction in the terminal voltage over that at no load if flashing is to be prevented. It should be noted, however, that the initial load condition results in a peak current that is higher than under the no-load condition. In contrast to this it was found that increasing the speed decreased the threshold value of terminal voltage and also decreased the magnitude of peak current.

An important factor in the flashing characteristics of a machine is the response of the interpole flux to the rapidly changing armature current. It is well known that the interpole flux is insufficient to give satisfactory commutation at high armature currents due to saturation effects. It is also of equal importance to realize that during high-current transients the interpole flux lags the change in current. This is illustrated in Figure 2. The lag in flux can be compensated, in part, by starting at full load where some interpole flux has been established. It was observed that under this condition higher values of short-circuit current were obtained before flashing occurred. The use of laminated interpoles in the machine, in place of the solid interpoles, resulted in a marked decrease in the time lag of interpole flux with respect to the transient armature current and decreased the susceptibility of the generator to flashover.

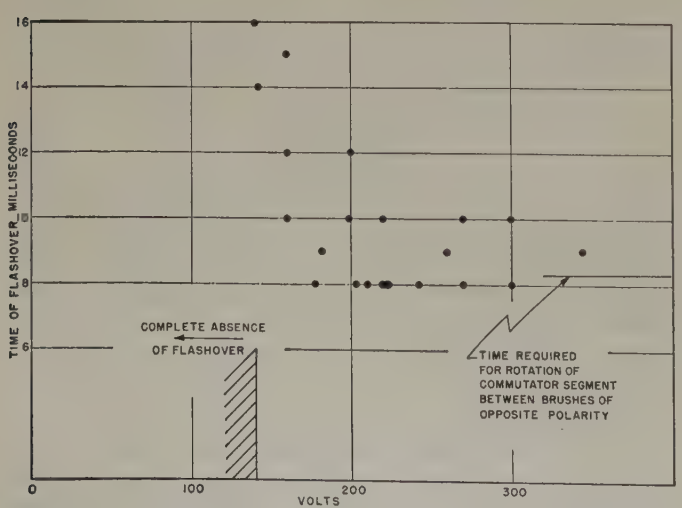


Figure 1. Flashing time of a 300-kw generator at 1,200 rpm

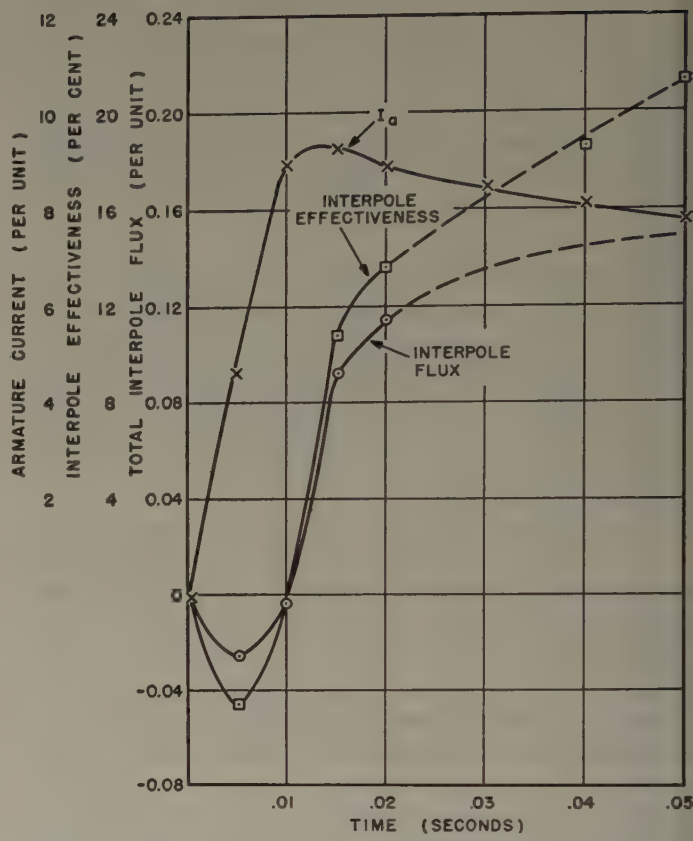


Figure 2. Interpole flux during transient armature current. Initial conditions: 250 volts, no load, 1,800 rpm, 90-horsepower motor operated as generator, solid iron interpoles

$$\textit{Interpole Effectiveness} = \frac{\textit{Actual Interpole Flux}}{\textit{Interpole Flux for Normal Commutation}}$$

Digest of paper 53-86, "Flashing of D-C Machines Caused by Short Circuits," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

A. T. McClinton and J. P. O'Connor are with the Naval Research Laboratory, Washington, D. C.

Plastic Electrets and Their Applications

H. H. WIEDER SOL KAUFMAN

The electret effect in high polymer plastics is described and compared to published data on the behavior of wax electrets. The results indicate the existence of large ionic polarizations giving rise to an essentially constant external electric field. Some engineering applications of electrets are discussed and limitations presented in terms of current knowledge of electret phenomena.

ALTHOUGH electrets made from carnauba wax have been the subject of considerable study,[1–12] relatively little attention had been devoted to electrets using radically different materials. In the hope of obtaining electrets with improved characteristics, an investigation was started on the nature of the electret effect in high polymer dielectrics. An attempt also was made to relate the behavior of plastic electrets to the observations and experiments made by others upon wax electrets; in addition some electret applications were examined in the light of materials and techniques presently available.

The electret is here defined as a dielectric which can maintain a sensibly permanent external electric field. Note that ferroelectrics such as the barium titanates could not be termed electrets for, although permanently polarized, they maintain only an internal electric field; nor would dielectrics which had been given surface charges which could be neutralized by water immersion or exposure to humid or highly ionized air be called electrets. Electrets, if treated in the foregoing manner, can recover their charges after being removed from the humid atmosphere or from the vicinity of the ionizing agent.

EXPERIMENTAL METHODS AND RESULTS

APPROXIMATELY 30 ELECTRETS using lucite, Plexiglas, and nylon have been prepared up to date. Preparation of an electret involves heating of the sample to a temperature in the neighborhood of its softening point while being subjected to a high-intensity electric field. The sample is allowed to remain in this state for several hours while it is being polarized and, if the polarization current is not masked by a too-high conduction current, it will have the typical behavior shown in Figure 1. After the total current has reached a stable state, the sample is allowed to cool rapidly to room temperature while still under the applied field. The forming temperatures for these samples is not critical. For lucite and Plexiglas it is in the vicinity of 150 degrees centigrade. For nylon it is in the neighborhood of 200 degrees centigrade. The conventional method of storage is to cover the active surfaces of the electret with a continuous conducting electrode, metal foil, or plates. This effectively short-circuits the external electric field and thus prevents neutralization of the surface charges due to external agents.

A measure of electret strength is set up by relating the external electric field to an effective surface charge density; the latter being measured by the principle of electrostatic induction. This technique has been covered in detail.[10,13]

Full text of a conference paper presented at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953, and recommended for publication by the AIEE Subcommittee on Energy Sources of the Committee on Basic Sciences.

H. H. Wieder is with the National Bureau of Standards, Corona Laboratories, Corona, Calif., and **Sol Kaufman** is with the National Bureau of Standards, Washington, D. C.

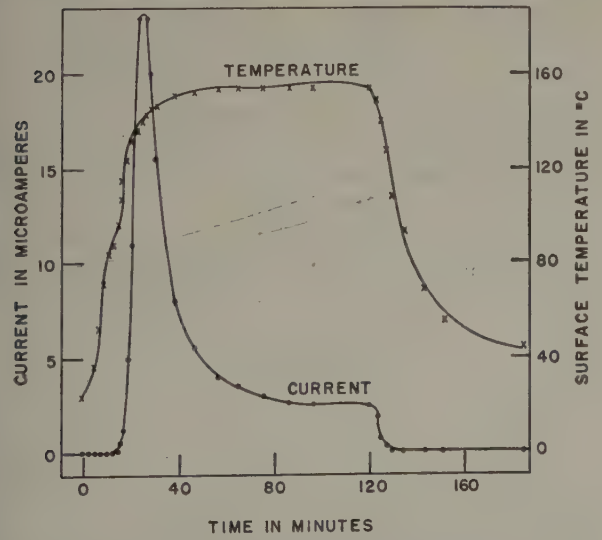


Figure 1. Total current versus time during formation of a Plexiglas electret

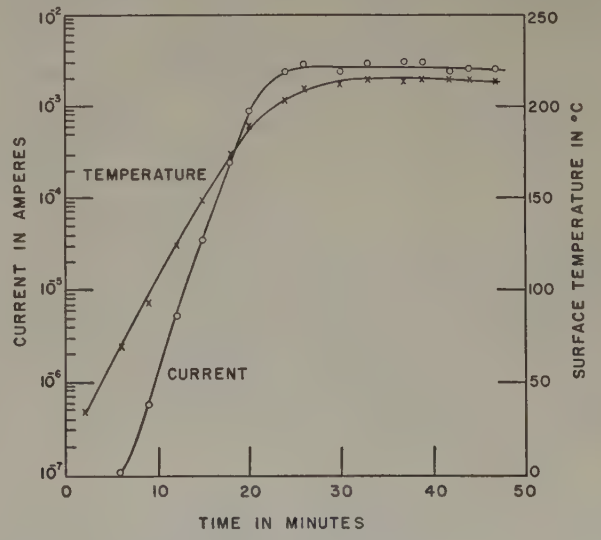


Figure 2. Total current versus time during formation of a nylon electret

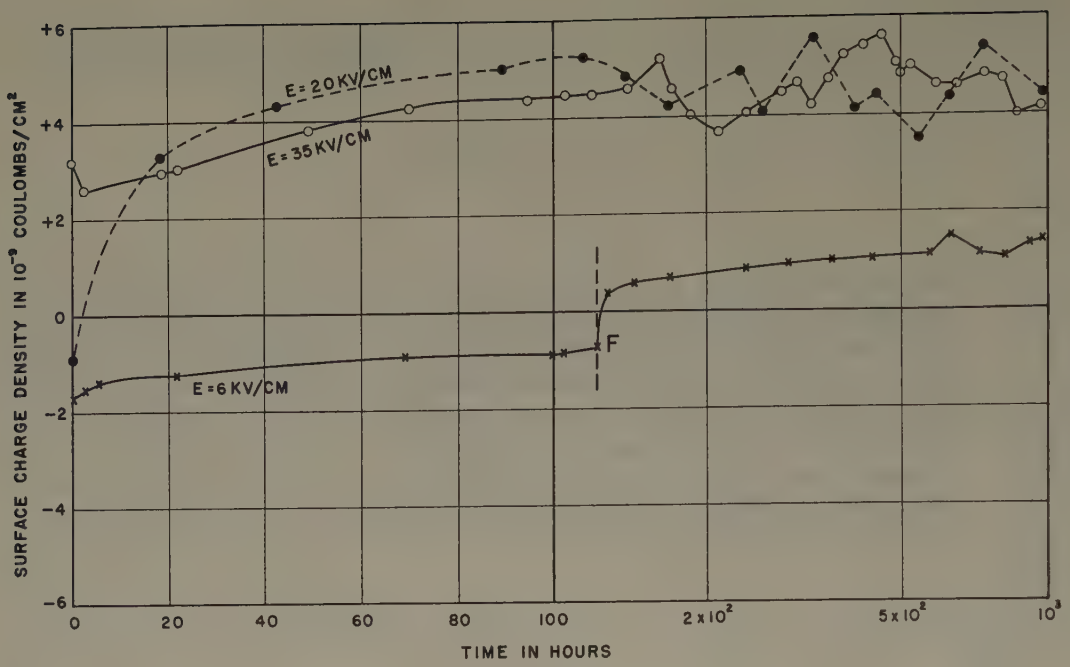


Figure 3. Surface charg density versus time fo lucite electrets formed a a temperature of 150 de grees centigrade, using th indicated field strengths At time t=F, and at 2 degrees centigrade a 5 kv per centimeter field wa superimposed on the elec tret causing the sharp sig reversal

It can be shown that plastic electrets will behave during and after formation in a manner similar to wax electrets. Some disparities, however, do exist: lucite and Plexiglas electrets exhibit during formation the typical polarization current observed for carnauba wax during the heating and subsequent cooling cycle, see Figure 1. In the case of nylon, however, the formation current differs in shap because of a higher conduction current; this in turn mask any polarization current which might be present, se Figure 2.

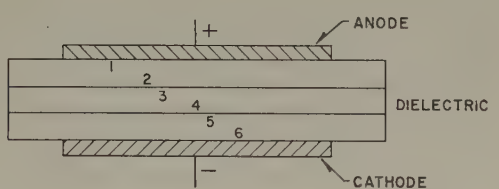
Lucite, Plexiglas, and nylon were successfully used i making electrets. Polystyrene, however, gave negativ results. An attempt to polymerize the latter under th influence of a high-intensity electric field did not indicat any electret behavior.

Using the terminology employed by Gross[6–8,10] two dis tinct charge densities can be defined: if the polarity of th electret surface be the same as that of the applied potentia during formation, the surface charge is termed a homo charge; conversely, if the polarity of the surface charg be opposite to that of the applied potential, it is termed heterocharge. In the case of the experimental plasti electrets, if the forming field was below 6 kv per centimete a slowly decaying heterocharge resulted. If the fiel strength was in the range of 20 to 25 kv per centimeter the electret had an initial heterocharge which subsequentl reversed to a homocharge. For field strength of the orde of 35 kv per centimeter, an initial homocharge and n reversal of polarity was noted consistently.

The results obtained are shown in Figure 3. The sample under study were disk shaped, from 2 to 4 inches in diam eter, and from 1/16 to 3/16 inch thick. The highes detectable charge density is limited to an order of magnitud of 10^{-9} coulomb per square centimeter due to air break down between the electrodes. It was ascertained that th aperiodic build-up and decay of charge, see Figure 3, wa not due to temperature or humidity variations. A nylo electret kept in a controlled atmosphere exhibited th same phenomenon. The recovery of a lucite electre after having been immersed in water is shown in Figure 4.

Thiesen et al.[9] had shown by dissecting an electret int parallel layers with respect to the cathode, that a spac charge exists within the wax electret. An attempt t do this with plastic electrets would have been difficul

Table I. Charge Densities on the Respective Surface Areas of a Plexiglas Electret Prepared From Three Individual Sections and Formed as a Unit



0.5 HOURS AFTER FORMATION CHARGE DENSITY ON EACH DIELECTRIC SURFACE

AREA	POL.	CHARGE DENSITY IN COULOMBS / Cm^2
1	−	3.0
2	+	3.0
3	−	1.7
4	+	2.2
5	+	3.0
6	−	5.4

IMMERSED ALL SAMPLES IN WATER AT 0.55 HOURS ALLOWED TO DRY AND MEASURED AT 20 HOURS AFTER FORMATION.

AREA	POL.	CHARGE DENSITY IN COULOMBS / Cm^2
1	+	0.5
2	−	0.4
3	+	0.3
4	−	0.1
5	+	1.2
6	−	2.4

650 HOURS AFTER FORMATION

AREA	POL.	CHARGE DENSITY IN COULOMBS / Cm^2
1	+	1.6
2	−	0.4
3	+	0.8
4	−	1.1
5	+	2.2
6	−	5.1

An electret was prepared, however, in the following manner:

Three Plexiglas disks 4 inches in diameter and 1/32 inch thick were temporarily pressed into a single disk using a very thin layer of silicone grease between the disks in order to insure that they could be pried apart after being formed into a single electret. A field of $E=$ 23 kv per centimeter was impressed upon the dielectric at a forming temperature of 150 degrees centigrade, the sample being processed in the usual manner for electrets. Results are indicated in Table I. In a qualitative way these results tend to support the data obtained by Thiesen[9] and Jaeger[12] and their assertion as to the existence of a space charge within the electret.

Some conclusions as to the nature of the electret are possible on the basis of experimental results: since the process of growth of a simple polarized charge distribution is unlikely, it is reasonable to postulate, in agreement with Mikola[5] and Gross,[10] the existence of two separate decaying charge distributions of opposite polarities. A differential in their decay rates could result in the apparent growth of the total charge density in the direction of a greater homocharge. This growth is eventually limited and an approximate steady state reached because of air breakdown. Both polarized distributions involve the mechanism of ionic charge. The alternative possibility that dipole orientation is the basis of inner polarization is unreasonable since the maximum surface charge density obtainable in this way (assuming complete alignment with reasonable magnitudes for dipole moment and dipole density) is 5×10^{-6} coulomb per square centimeter. In contrast, the actual charge density due to inner polarization, heterocharge, computed by integrating the displacement current-time curve of Figure 1, is found to be 5×10^{-4} coulomb per square centimeter, assuming conductivity to be independent of time.

ELECTRET APPLICATIONS

An electret subjected to a rise in temperature will deliver a current to an external impedance connected to its electrodes; it will, however, be irreversibly discharged in the process.[6] It must be emphasized that in any other way an electret is not to be considered as an energy source.

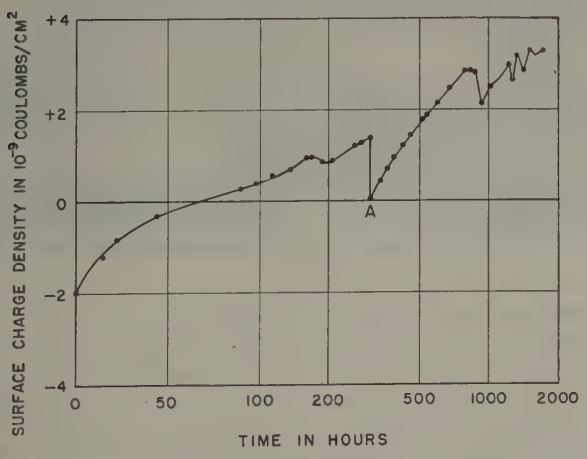


Figure 4. Surface charge density versus time for a lucite electret. Initial heterocharge, reversal to homocharge at 70 hours, recovery of homocharge after water immersion

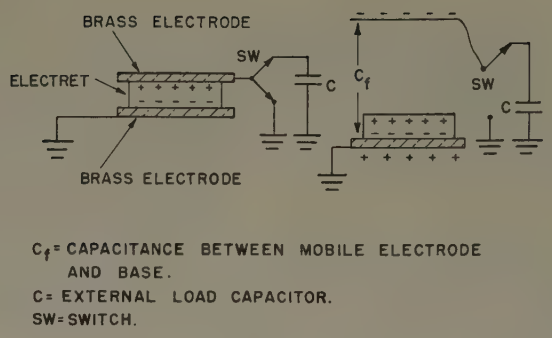


Figure 5. The electret as a high-potential–low-capacitance source

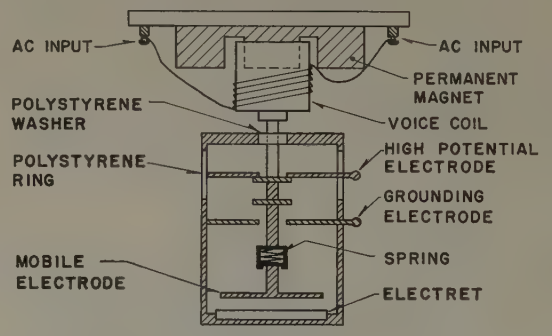


Figure 6. An electrostatic generator employing the external field of an electret

A number of applications utilizing the permanent electric field of the electret have been verified experimentally and are indicated in the following:

1. *High-Voltage (Low-Capacitance–High-Impedance) Source.* Starting with the upper electrode grounded then raised from the electret surface and subsequently connected to an external load, the induced charge is transferred to the external capacitor C. Figure 5 shows the operation of this circuit.

Obtained numerical values for a lucite sample 4 inches in diameter and 1/8 inch thick were

$Q=3\times10^{-7}$ coulomb
$C_f=20$ micromicrofarads
$C=30$ micromicrofarads

Since: $V=Q/C+C_f$, $V=6$ kv

2. *Electrostatic Voltage Generator.* If the value of C used in the previous case is increased considerably and the action of moving the electrode is repeated, the capacitor is charged through a cumulative process. At the beginning, the voltage increases almost linearly at the rate of $V=Q/C+C_f$. This corresponds to roughly $V=Q/C$ per cycle.

A limiting voltage is asymptotically reached, at which level no further charge is transferred to the capacitor. This limiting voltage is $V_m=Q/C_f$. For the foregoing values $V_m=15$ kv (providing breakdown does not occur).

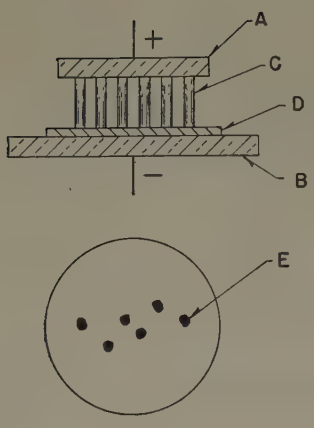


Figure 7. Electrode arrangement for producing localized electret areas in a dielectric, and resultant configuration of the electrets:

A = anode block; B = cathode block; C = cylindrical anodes; D = dielectric; E = electret area

A simple electrostatic generator is shown in Figure 6. It is important that the time interval while the electrode is left ungrounded be as short as possible, otherwise the electret surface charge will decay logarithmically after a few operations. (It will, however, recover if allowed to remain in a short-circuited condition.)

3. *A-C Generator.* If the external load be a resistor, then an electrode working against the electret field and executing harmonic motion will deliver an alternating current into the load. A qualitative experiment was performed using a lucite electret. The advantage of this type of operation is that no contacts or commutators are required (provided the load impedance is not too high).

Electrets also could be operated in push pull or in parallel thus increasing the total charge transferred to a load. Any other type of motion whether circular, impulse, or reciprocating, can be used to obtain an electrostatic generator by means of electrets. The electret is a very-high-impedance source. An experimental rotating electret generator was capable of delivering a continuous current of 10^{-7} ampere to a load which varied between 100 ohms and 100 megohms. Thus an electrostatic generator conceivably could be used as a high-impedance constant-current source.

4. *Electrostatic Memory.* By fashioning one of the electrodes as shown in Figure 7, localized areas of a dielectric can be made into an electret. Domains 1/4 inch in diameter and as close as 1/4 inch to each other may be made into electrets without polarizing the rest of the dielectric.

CONCLUSION

THE EXPERIMENTS OUTLINED in this article indicate that the mechanism of polarization is the same in high polymer dielectrics as in carnauba wax. Although the basic mechanisms of polarization are not completely determined, the work described tends to support the theories of Mikola and Gross, postulating, however, the idea that both the homocharge and the heterocharge are of an ionic nature.

The physical and chemical properties of dielectrics that would make suitable electrets remain largely undetermined. Two necessary conditions are, however, to be noted: the dielectric should have a resistivity of the order of 10^{14} ohm-centimeters, and the electret should have a softening temperature well above the ambient temperature at which it is stored.

It is the authors' belief that by using materials such as ceramics and glasses better physical and electrical properties could be obtained for electrets, and that by proper packaging and sealing these properties could be made independent of temperature and humidity thus opening a wider range of application.

REFERENCES

1. The Electret, **F. Gutmann.** *Reviews of Modern Physics* (New York N. Y.), volume 20, 1948, page 457.

2. On Electrets, **E. P. Adams.** *Journal*, Franklin Institute (Philadelphia, Pa.), volume 204, 1927, page 469.

3. Recent Investigation on Electrets, **A. Gemant.** *Philosophical Magazine* (London, England), volume 20, 1935, page 929.

4. Homocharge of Electrets, **Andrew Gemant.** *Electrical Engineering*, volume 6 number 7, July 1949, page 644.

5. On the Permanent Polarization of Solid Dielectrics, **S. Mikola.** *Zeitschrift f Physik* (Berlin, Germany), volume 32, 1925, page 476.

6. Experiments on Electrets, **B. Gross.** *Physical Review* (New York, N. Y.), volum 66, 1944, page 26.

7. On Permanent Charges on Solid Dielectrics II, **B. Gross.** *Journal of Chemical Phy ics* (New York, N. Y.), volume 17, 1949, page 866.

8. On Permanent Charges of Solid Dielectrics **I. B. Gross, L. F. Denard.** *Phys cal Review* (New York, N. Y.), volume 67, 1945, page 253.

9. Electric After-Effects in Solidified Dielectrics, **P. A. Thiesen, A. Winkel, Hermann.** *Physikalische Zeitschrift* (Leipsig, Germany), volume 37, 1936, page 51

10. Static Charges on Dielectrics, **B. Gross.** *British Journal of Applied Physics* (Lon don, England), volume 1, 1950, page 259.

11. On Certain Matters Pertaining to Electrets, **W. F. G. Swann.** *Journal*, Fran lin Institute (Philadelphia, Pa.), volume 250, 1950, page 219.

12. Space Charge Measurements During Solidification and in the Solid Stat **P. Jaeger.** *Annalen der Physik* (Leipsig, Germany), volume 21, 1934, page 481.

13. Plastic Electrets, **H. H. Wieder, S. Kaufman.** *Journal of Applied Physics* (Ne York, N. Y.), February 1953, page 156.

Crane for Turbine Service

Shown above is a 275-ton Gantry crane designed and built b the Bedford (Ind.) Foundry and Machine Company and installe by Ebasco Services, Inc., for the Washington Water Power Com pany's Cabinet Gorge Hydroelectric Station near Clark Fork Idaho, where four large generators will have been placed i service by July 1953. The crane, designed to withstand extrem weather in full-time outdoor service, has safe overload capacit which enables it to handle the massive rotors weighing up to 33 tons each. It is intended for general service work over the tur bine area

Accurate Radio-Frequency Microvoltages

M. C. SELBY

THE RADIO AND electronics field has been facing the problem of accuracy of radio-frequency microoltages since sensitivity of radio receivers came into rominence as a competitive index of performance.

In searching for a source of accurate and reliable radioequency microvoltages the following basic requirements eemed indispensable or highly desirable:

(*a*). The output voltages of the source had to be known rrespective of loading conditions, that is, a constantoltage source was necessary.

(*b*). Freedom of frequency corrections was essential at east over reasonable frequency ranges.

(*c*). A reliable, simple, and rugged physical conruction with a very minimum of component parts was ost desirable.

(*d*). The simplest and very minimum of calibration equirements were essential.

All of these requirements seem to be satisfactorily chieved with the new device briefly described and reerred to here as a "Micropotentiometer." The equivaent circuit is that of a coaxial line shunted by a conducve film in a plane normal to the axis of the line, as hown in Figure 1. A source of radio-frequency energy upplies current to the Micropotentiometer section of the ystem through a coaxial line and the voltage output, V, rom the Micropotentiometer, available across the annulus, fed to the receiver. To a very good approximation, V simply the product of the input line current entering he annulus and the d-c resistance of the annulus. This ollows from the general field-theory treatment of the oregoing conductive annulus as a section of a coaxial line ith an intrinsic impedance corresponding to that of the articular conductive medium. The absolute value of the ransfer impedance, $|Z_m|$, of a transmission-line section, -centimeters long, having a relatively high-conductive ielectric medium and a skin penetration, δ, is

$$|Z_m| = |R_m(1+j)(d/\delta)\ csch\ [(1+j)d/\delta]|$$
$$= R_m\left|1 - j\frac{d^2}{3\delta^2} - \frac{7}{90}\frac{d^4}{\delta^4} + \ldots\right|,$$

here R_m is the d-c resistance of the annular element.

Thus $|Z_m|$ is equal to R_m to better than 1 per cent for $/\delta \leq 0.5$ and

$$=I_1|Z_m| \cong I_1 R_m$$

here I_1 is the current entering the line section, that is, he annular resistor.

One of several variations of this device is shown in igure 2. Agreement tests were conducted against a oltage-standardizing bolometer bridge and precision aveguide below cutoff attenuators. These tests indicated

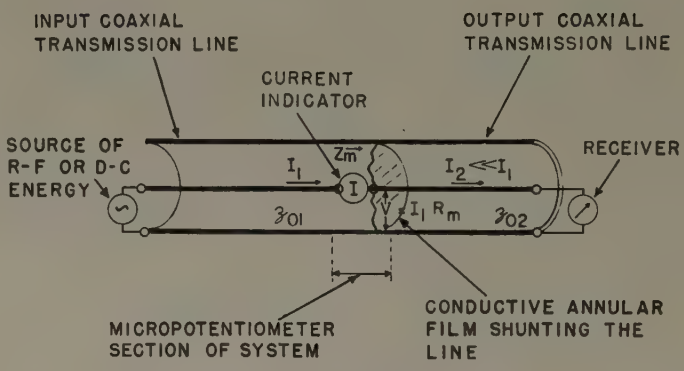


Figure 1. Equivalent circuit diagram of system employing a Micropotentiometer

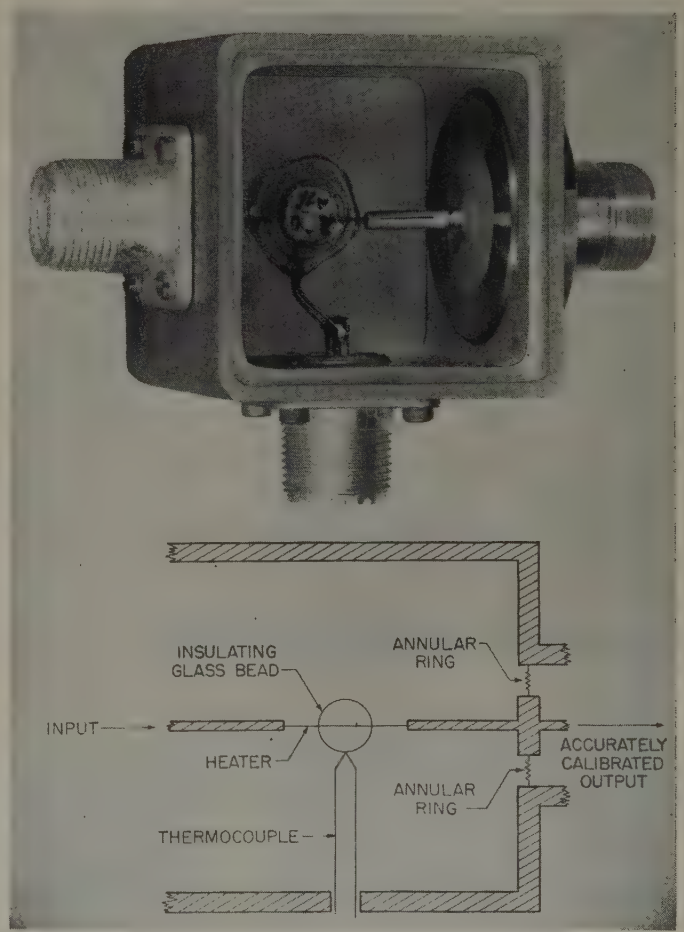


Figure 2. Micropotentiometer employing a thermoelement as a current indicator

agreement well within over-all experimental errors, that is ±1 per cent to about 50 megacycles, ±3 per cent to 300 megacycles, and ±5 per cent to 900 megacycles.

Digest of paper 53-22, "Accurate Radio-Frequency Microvoltages," recommended by the AIEE Committee on Instruments and Measurements and approved by the AIEE Technical Operations Committee for presentation at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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Single-Phase Motor Design to Minimize Voltage Dip

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A REDUCTION OF THE VOLTAGE DIPS and light flicker caused by the starting of single-phase motors can be accomplished by decreasing the power component of the starting current or by shifting the starting power factor to a more leading value. Both of these adjustments are made in a new type of capacitor-start motor which causes voltage dips only half as great as are produced by the usual capacitor-start motor. The new motor is larger and employs a new starting circuit with the capacitor in series with the main winding during the starting period.

Starting characteristics of 1/3- and 1/2-horsepower motors of the new design are compared with those of the usual capacitor-start motors in Table I. The new 1/2-horsepower motor has been built and tested. It has good accelerating torque and acceptable running performance. At full load the new designs have efficiencies and power factors two to three percentage points poorer than the usual capacitor-start motors.

The outstanding feature of the new designs is the reduction of starting power input while maintaining approximately the same starting torque. Three features of the new designs are responsible for the large reduction in starting power input. These features are increased rotor resistance, reduced auxiliary winding resistance, and improved phase splitting.

The new 1/2-horsepower motor is built in a frame which normally accomodates a 3/4-horsepower standard motor.

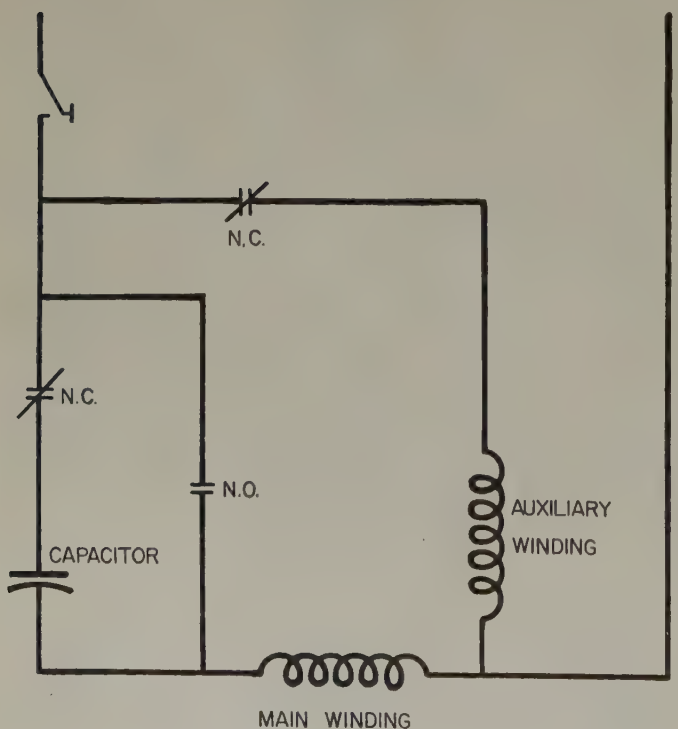

Figure 1. New starting circuit

Table I. Comparison of Starting Characteristics

	1/3-horsepower Motor		1/2-horsepower Mot	
	New Design	Standard Design	New Design	Standard Design
Torque (ounce-foot)	68.3	65.1	102	107
Current (amperes)	19.2	27.6	27.5	42.7
Power (watts)	1950	2845	2900	4580
Power Factor (per cent)	89.5	89.6	91.5	93.0
	I leads	I lags	I leads	I lags
Torque Efficiency (per cent)	56.0	36.6	56.3	37.4
Capacitor Size in Microfarads	316	260	416	430

Use of the same number of main winding turns as in th 3/4-horsepower motor permits a 60-per-cent increase rotor resistance without excessive slip or running losses a 1/2-horsepower load. Total stator losses at start are re duced by a redistribution of stator copper. An 11-per-cen reduction in main winding copper permits a 37-per-cen increase in auxiliary winding copper. The starting circui of Figure 1 is used. Auxiliary winding turns and capacito size are selected to give the desired torque and nearly per fect phase splitting at start.

The power factor of the new motor is usually leading a start. If the desired starting torque is 450 per cent or les the best phase splitting is achieved with more auxiliar winding turns than main winding turns. The current i the main winding at start is larger than the current in th auxiliary winding and the total current leads the applie voltage.

The new motor has several disadvantages. Higher cost the principal disadvantage of the new motor described i this article. If manufactured in as large quantities as th present capacitor-start motors the costs would be approx mately 35 per cent higher. If manufactured in small num bers the costs would be very much higher.

The main winding current is conducted through a moto switch contact all the time the motor is in operation; there fore, the probability of switch failure is greater than in th present capacitor-start motors.

The new starting circuit does not permit dual voltag ratings and is not practical for capacitor-run motors.

General adoption of the motor features described in th paper perhaps is not economical for the popular sizes fractional-horsepower single-phase motors. These feature however, can be advantageously employed in the design larger motors with low starting currents. A 3-horsepow 230-volt single-phase motor with 200-per-cent startin torque can be built with a starting current of 50 amper at a power of 0.75 leading. The development of he pumps and home air conditioners may bring a demand f larger single-phase motors with low starting current.

Digest of paper 53-141, "Design of Single-Phase Motors to Minimize Voltage Dip recommended by the AIEE Committee on Rotating Machinery and approved by t AIEE Committee on Technical Operations for presentation at the AIEE Winter Gene Meeting, New York, N. Y., January 19–23, 1953. Scheduled for publication in AI *Transactions*, volume 72, 1953.

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The XY Toll Ticketing System

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In order to bolster the decreasing net profits of independent telephone companies on short-distance toll calls, automatic toll switching equipment with automatic ticketing has been developed. The ticketing system temporarily stores data on a magnetic tape from which the information is printed as a toll ticket.

IN RECENT years independent telephone companies have become acutely aware of steadily decreasing net profits on short-distance toll call operation. The recording for billing purposes of certain information concerning the toll call has required the assistance of an operator. For this reason, manual toll switching has been retained in spite of the fact that mechanical systems for performing the actual switching functions have been available for many years. Fixed toll charges and rising labor costs have combined to make it extremely difficult for the operating companies to realize a profit on this phase of their business.

One solution to this problem is the granting of free service on these loss-producing toll lines. While this would prevent further losses, resulting increased traffic would create a demand for additional expensive plant equipment and personnel, which in turn would produce no revenue.

A second solution is the reduction of the number of people involved in producing the toll billing records known as "toll tickets," by the installation of automatic toll switching equipment incorporating automatic ticketing means. Several attempts have been made to provide such equipment and two basic types have emerged.

One, the verifying type, requires the calling subscriber to dial his own directory number before dialing the number of the desired station. The other, considerably more complex and expensive, is the identifying type wherein the calling station number is automatically found and recorded without effort on the part of the subscriber.[1] The system described herein is of the verifying type.

Any toll ticketing system, manual or automatic, must accomplish three things: 1. The information concerning the toll call must be recorded in some manner. 2. The recorded information must be translated and interpreted for use by the ticketing device. 3. The information must be presented finally in a readily usable form.

RECORDING THE INFORMATION

SINCE THE PRIMARY objective of any toll ticketing system is the reduction of manual labor in producing the toll tickets, the most desirable system would be the one which would reduce the labor factor to zero. In order to achieve such a goal, the designer is confronted with the need for an inexhaustible medium on which to store, temporarily, the billing information until that information is printed as a toll ticket. Several such storage devices are available, only one of which is economically sound.

The Recorder. The unique magnetic tape recorder shown in Figure 1*A* forms the heart of the *XY* Toll Ticketing System as the intermediate storage device. The tape in the magazine can record information concerning 100 average toll calls before it requires automatic interpreting equipment to print the tickets, simultaneously preparing it-

Full text of paper 53-184, "The XY Toll Ticketing System," recommended by the AIEE Committee on Communication Switching Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Southern District Meeting, Louisville, Ky., April 22–24, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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The author wishes to acknowledge the contributions of F. A. Morris, J. D. Confeld, and H. S. Gleason to whom should be credited the major portion of the circuit and mechanical design of the *XY* Toll Ticketing System.

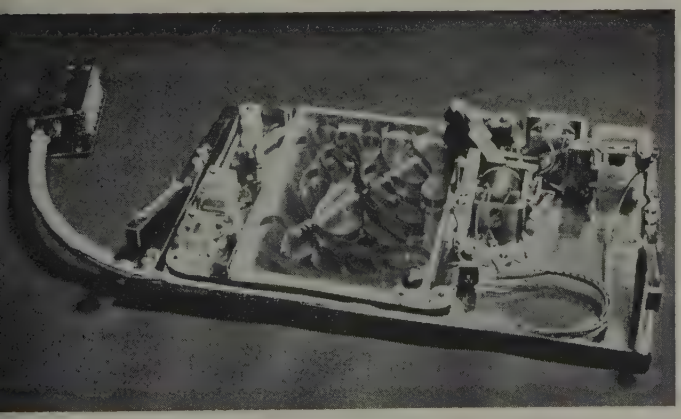


Figure 1A. The trunk recorder-reproducer which is used in the XY Toll Ticketing System. The magnetic tape in the magazine can record data on 100 average toll calls

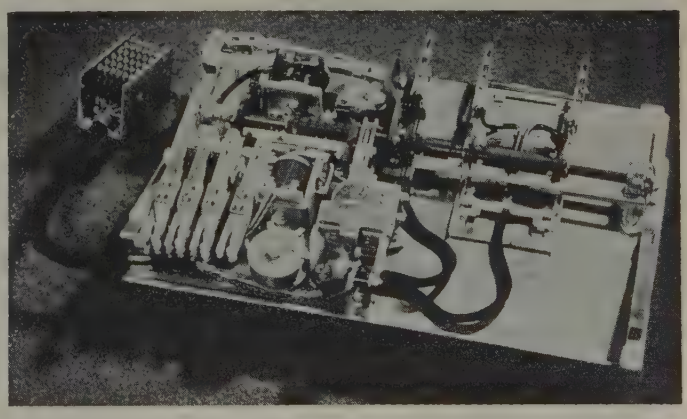
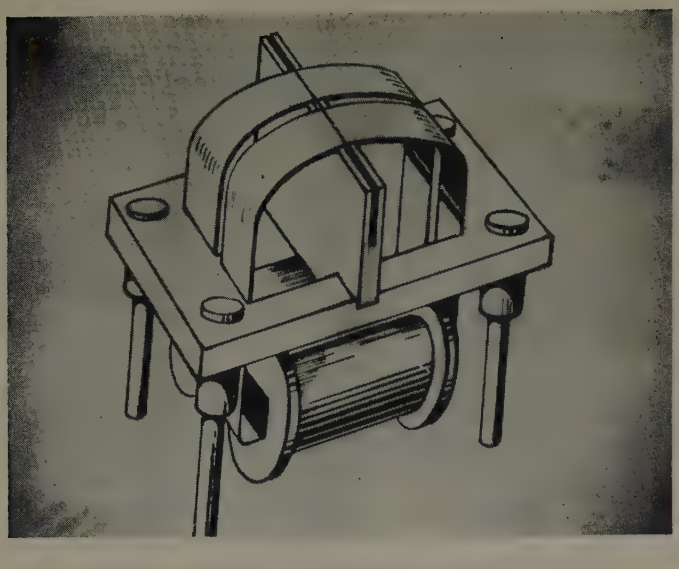


Figure 1B. The universal switch for use in any circuit in a step-by-step dial telephone system. Note the similarity of parts with the recorder-reproducer of Figure 1A



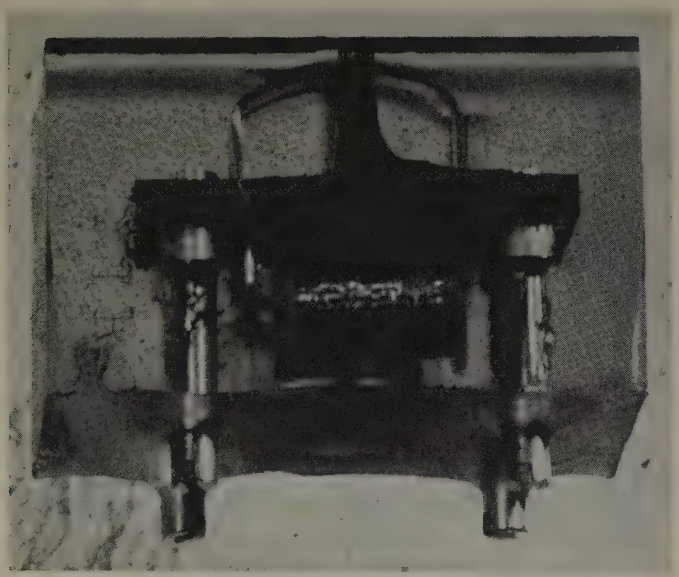


Figure 2. Above is shown the twin-track record-playback head before being molded in resin and below is shown the resin casting containing the head

self for reuse. One recorder is permanently associated with each toll trunk, operating completely unattended in all of its functions. The recorder records the calling and called subscribers' directory numbers, the duration of the call (elapsed time), the time of day, and the date.

Figure 1*B* shows the *XY* Switch manufactured by Stromberg-Carlson Company. This is a universal switch for use in any circuit in a step-by-step dial telephone system. Comparison with Figure 1*A* will show the similarity between the recorder and the switch. Great savings in tooling and manufacturing costs were achieved by using as many identical parts as possible in the two devices. Both are built on the same plate, use two of the same magnets, mount in the same way, and are jacked into the associated trunk relay equipment by means of identical cord and plug assemblies. Thus, the entire design of the *XY* Toll Ticketing equipment can be harmonious with standard *XY* switching equipment.

The recording is made on standard 1/4-inch magnetic tape. Approximately 30 feet of tape are contained in the magazine in the form of an endless loop. The tape is transported by a capstan which can be driven by either of two methods. For recording, the tape is advanced step by step in 0.057-inch increments by means of a ratchet drive. For playback, a clutch connects the capstan to a common motor shaft and the tape is driven at a constant rate of about 3 inches per second. The tape passes over a twin-track recording head and a double-width erase head. Felt-faced pads apply the necessary pressure to assure proper contact between the tape and the heads. Three contact springs, sensing two conductive areas applied to the back side of the tape, control the cycling of the recording and playback process.

The Tape Heads. Figure 2 shows the twin-track record-playback head before and after it has been cast in resin. Each head consists of a single 0.112-inch-wide lamination of molybdenum permalloy with a 1-mil gap spacer. The coils are 2,700 turns of Number *46* wire wound on a bobbin. The various parts are mutually supporting and interlocking. The erase head is built on the same principle, the lamination being 0.270 inch wide and its coil 50 turns of Number *27* wire.

The upper half of the twin-track head is energized by each dial impulse and makes a magnetic impression 0.002 inch wide on the upper half of the tape. The lower half of the head is energized upon release of the interdigit relay in the trunk circuit which also effects the advance of the tape by a single step. These interdigit pulses serve to separate the several groups of pulses derived from the dialed digits. The two series of pulses are known as "mark" and "space" pulses, respectively. To indicate the end of a call, mark and space pulses are recorded simultaneously when the trunk is released.

Block Diagram. Figure 3 shows a block diagram of the *XY* Toll Ticketing System, while Figure 4 shows the equipment itself, except for the trunk circuit. The digits of the subscriber's own number are used for two purposes. They are recorded in order to bill the call and they also set up a connection to verify the accuracy of the number dialed. If the call is verified, the verifying circuits are dropped off and subsequent pulses (of the called number) are passed over the trunk to establish the connection to the distant subscriber. As soon as the called subscriber answers (answering supervision), the trunk transfers the recorder input to a common time impulse circuit, the minute pulser transmitting one impulse per minute to the recorder during the conversation. When the calling subscriber hangs up (on-hook supervision), the trunk drops the linkage and transfers the input of the recorder to a common clock calendar. Digital representation of the time of day and date is automatically pulsed into the recorder. Upon completion of this operation the trunk releases and causes an end-of-call signal to be recorded. The trunk and its associated recorder are then free to accept another call.

If the calling subscriber dials other than his own number the call will not be verified and subsequent pulses are neither recorded nor repeated to the distant office. This condition is indicated to the subscriber by means of

uitable tone. Upon receiving on-hook supervision the runk merely will enter an end-of-call signal and release. imilarly, in the case of "don't answer" and busy line calls, ne trunk will enter an end-of-call signal—omitting the me and date information—and release. The presence of ne date and time of day information is the criterion for the layback equipment to print a valid ticket. All abnormal alls are therefore ignored by the printing equipment.

Interpretation and Presentation. Common playback equipent attaches itself to each trunk recorder according to a rearranged schedule to permit common interpreting quipment to analyze the information recorded on the agnetic tape recorder. The interpreting equipment perates a ticket printer, common to all recorders, which rints a standard size toll ticket and automatically stacks ese tickets, printing up to 10,000 per day. If complete utomatic billing is desired, the information can be directed nto a card-punching machine instead of the printer. In his case, 15,000 calls can be ticketed per day, since the card unch will operate somewhat faster than the printer.

Playback Control Circuit. Due to the large storage capacity f the trunk recorders, it is necessary and desirable to interret the stored information only periodically—the period eing determined by the toll traffic. Presumably, this ould be once a day during a time of light traffic. The common clock-calendar unit is so wired that it will start playback at a predetermined time. The playback control circuit consists of a rotary switch and relays which function on a common equipment basis to augment the trunk during the playback cycle. The rotary switch acts as a trunk finder, stepping until the first idle trunk is found and associating the common control equipment upon seizing the trunk.

In the event that unusually heavy traffic conditions should cause a tape to become completely filled before the normal playback period, the normal schedule is ignored and the services of the playback control circuit requested at once. The rotary switch will advance directly to the full trunk and begin ticketing the calls from the recorder.

The "full" tape condition is sensed by the two conductive areas (foils) on the back of the tape. Should a subscriber seize the trunk and recorder just before the first foil is sensed, the recording of the data concerning the call will carry the tape past this point. Upon receiving on-hook supervision the trunk immediately busies itself out and calls for playback as described previously. A "safety zone" has been provided to take care of long conversations in this area. Should the subscriber pass the first foil and the conversation continue for 99 minutes, the second foil will be sensed, indicating an absolute "deadline." However, a super-safety area has been provided so that when the second foil

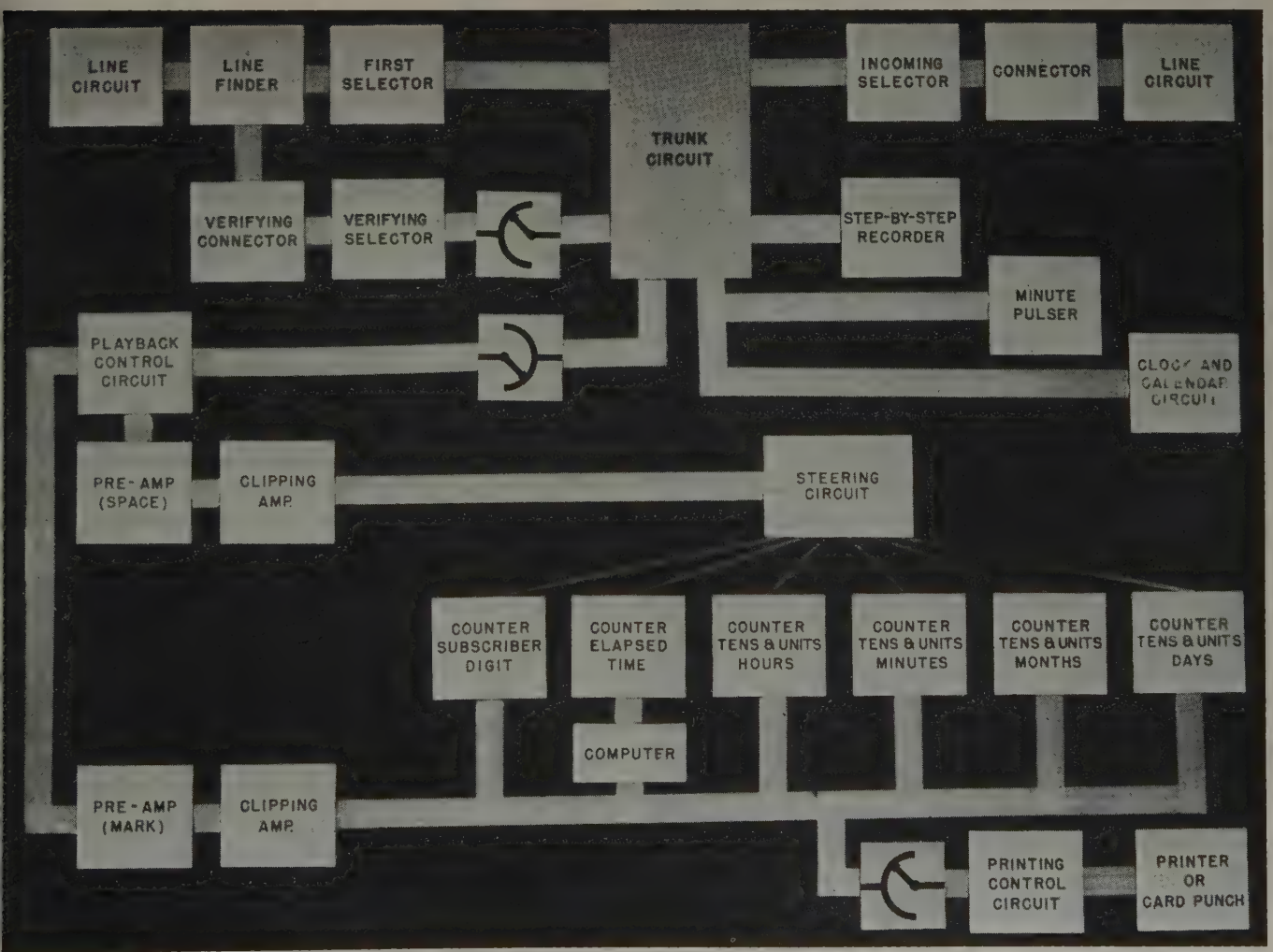


Figure 3. Block diagram of the XY Toll Ticketing System

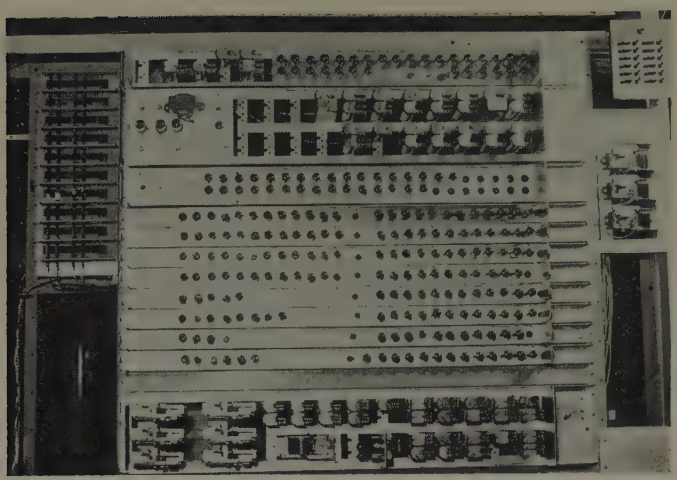


Figure 4. The equipment of the ticketing system without the recorders and the trunks

gives a forced disconnect, there still remains sufficient tape on which to record the date and time of day. If desired, the call can be continued by a manual operator rather than forcing disconnect.

Printing Control Circuit. The clutch of the recorder of the seized trunk is energized to move the tape to its "home" position. This is determined by the foil on the back of the tape. Control of the clutch is then transferred to the printing control circuit and the outputs of the twin record-playback head are connected to the mark and space preamplifiers. The recorder remains under the control of the printing control circuit until the tape has been completely played back and erased, whereupon the playback control circuit takes over once again. Before the trunk is released, a single reset signal is recorded for purposes to be discussed later.

Upon releasing the trunk the rotary switch advances and

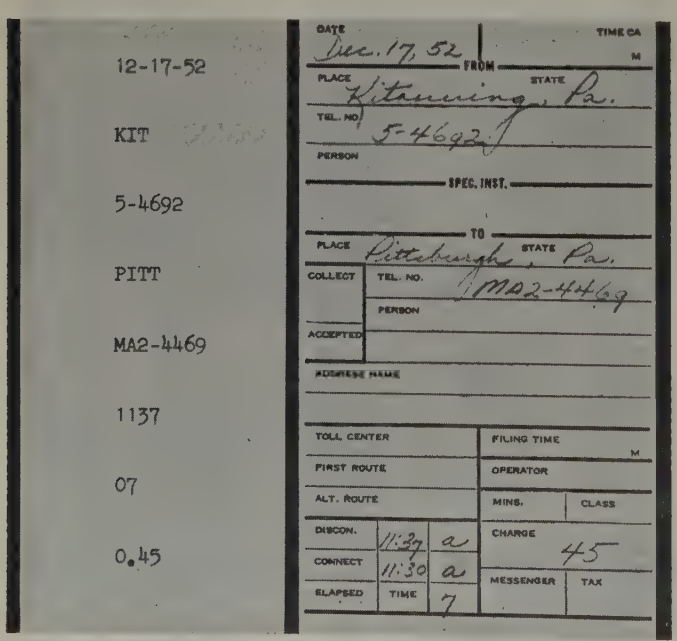


Figure 5. On the left is a toll ticket printed by the XY System which can be compared with a hand-written ticket on the right

associates the playback control circuit with the next idl trunk to repeat the playback process. After completing search through all of the trunks the rotary switch will reac home and the playback control circuit normally will becom inactive until the next scheduled start. After being ampl fied in the preamplifiers, the mark and space pulses are fe to the clipping amplifiers which further amplify the signa to a level suitable for driving the counting chains. Th clipping amplifiers also act as marginal devices and will nc transmit low-level signals resulting from interference. Th signal pulses are shaped and brought to a uniform size b these amplifiers which have a very large range. Pulse having as little as 30 per cent of "standard" amplitude ar transmitted and restored to full amplitude. The cutoi below that point is very rapid so that pulses only slightl less are completely eliminated. Pulses may be man times larger than standard and still be restored.

Steering Control Circuit. The function of the steering cor trol circuit is to energize the proper circuits to count an store the recorded digits. When the steering control circui is primed, it enables the first counter, which will count an store the first digit. Upon receiving a space pulse, th steering chain will be advanced to the next step enablin the second counter to count and store the second digit, an so forth. The steering chain will have as many stages a there are total digits of billing information.

Counters. With a playback tape speed of about 3 inche per second, the stored pulses are read off the tape at abou 68 per second. Relay counting chains for counting an storing at this rate are extremely complex and expensive Cold-cathode counting chains, on the other hand, can coun very comfortably at this rate. One counting chain is use per digit of billing information, but the several chains var somewhat in number of counting stages depending upon th maximum number of pulses expected. Those used fo subscriber digits must count to 10, whereas those countin tens days, for instance, need count only to 3. Where large number of pulses must be converted into a 2-digi decimal number (for example, the elapsed time can hav as many as 99 pulses) there is no single symbol for th quantity 99 and it must be represented as two 9's. This i accomplished by connecting the ends of a counting chai together to form a "ring." This ring will represent th units digit of elapsed time. It will continue to coun around, repeating as many times as necessary. Howeve for every time the units ring returns to zero, one pulse wi be fed into an associated chain to represent the tens digit the elapsed time. Thus, if 45 pulses, representing 4 minutes of elapsed time, are fed into the counter, the uni ring will return to zero four times, thus stepping the ter chain to four and will stop on the fifth tube in the rin representing units digit five. This automatically converts continuous series of pulses into two decimal digits.

Interpretation. The information stored in the severa counters must be transferred to the ticket printer a digit at time. By connecting the anodes of the counter tubes t the banks of the rotary switch it is possible to determin which tube is fired in each of the counters. Note that th information thus stored may be read, and the ticket printe

n any order. A printed ticket is shown with a manually written ticket in Figure 5.

Due to the requirements of the ticket printer it is necesary to translate the decimal information into a permutation ndicative of the numeral or letter to be printed. This ranslation is accomplished by a group of relays which are onnected by the rotary switch to the anodes of the counter ubes. The ticket printer employs a 7-unit code so arranged hat the operation of any single translating relay will result n printing a numeral. Combinations of two relays will ésult in printing a letter. The ticket printer and the rinting control circuit are interlocked by the simple exedient of advancing the rotary switch by means of a pulse ransmitted from a cam in the ticket printer.

Some of the information on the toll tickets is determined y means other than recorded data. The names of both he originating and called offices are determined by the peration of relays under the control of the playback control ircuit which puts the proper letter codes on the proper erminals of the rotary switch banks. Likewise, the digits epresenting the year are strapped on the proper bank erminals. Information needed by the printer, such as arriage return, line space, ejection, and so forth, is strapped n.

The printing control circuit acts to correlate the functions f the playback control, steering, counters, and printing ontrol circuit. Included in the printing control are the "destination code" relays which determine what trunk is eing ticketed and thus control what office letters are rinted on the ticket. These same relays are also used to djust the computer for the proper base time and base rate.

The printing and playback control circuits are carefully nterlocked so that playback cannot proceed unless the ounters are in a receptive condition nor can control by he printing control be relinquished until the information is ompletely interpreted. To make certain that the counters lo not contain any information left over from previous icketing or other interference the playback control transnits a reset signal each time a new trunk is seized. As an dditional precaution a reset signal is also recorded at the eginning of each tape as mentioned earlier. The reset ignal is simply an end-of-call recording, which, when not receded by normal ticketing information, serves to restore ll of the counting chains to the starting condition. After he two safety resets the counters receive and store the call nformation, storing all information about one call before ny other action takes place.

THE COMPUTER

THE COMPUTER makes use of the elapsed time and destination code information to derive the charge for the all. It too uses cold-cathode counting chains to calculate he charge. Essentially, there are two chains and two ings. One chain counts off the minimum time for the articular call, the number of stages in the chain being djusted by the destination code relays. If the call is based n a 3-minute period, for example, there will be three tages in the chain.

The first ring counts off the number of 5-cent increments since all short-haul charges increase at the rate of five cents per minute), the second ring counts the 10-cent increments and the second chain counts the dollars.

The minimum charge is primed into these counters by means of the destination code relays. If the call is based on 15 cents minimum charge, the 5-cent tube and the number 1 10-cent tube will be primed and the charging will start at that point.

The elapsed time pulses are fed into the computer which at first counts them in the minimum-time chain. When the end of this chain is reached, the remaining pulses are diverted into the first money ring which will add five cents for each additional minute, the total being kept by the remaining two counters. The calculated charge is read by wiring the anodes of the counters to the rotary switch just as the other numerical information in the counters.

Figure 6. The ticket printer consisting of an electric typewriter and a "translator" to make it respond to an electric control

THE TICKET PRINTER

THE BASIC MECHANISM of the ticket printer shown in Figure 6 is an electric typewriter to which the Commercial Controls Company adds what is known as a "translator" to make it respond to electric control. Essentially, the translator is much the same as the selecting mechanism in a Teletype machine.

For the *XY* Toll Ticketing System the ticket printer is further modified to the extent of adding a device for feeding

roll paper into it and converting the continuous roll into individual tickets neatly stacked.

The paper rolls are sufficient for 10,000 tickets, the paper being standard toll-ticket width. It is fed to the platen through guide channels, and after passing around the platen and being printed, it passes through another guide channel to a solenoid-operated chopping knife. After being cut off the ticket is ejected into a stacking hopper.

The only power required for recording the toll call information is the normal office battery at 48 volts direct current. For playing back and ticketing, 110-volt a-c power is needed. The anode voltage for the cold-cathode tubes is derived from a simple 500-milliampere 150-volt d-c power supply.

CONCLUSIONS

THE *XY* Toll Ticketing System meets the needs of the small- and medium-size telephone companies in their endeavor to solve the problem of decreasing profits i short-distance toll operation. By combining three basi arts—mechanical switching, magnetic recording, and elec tronics—the tickets for the toll calls are prepared in an desired form completely without manual attention, thu reducing to a minimum the high labor cost involved in to billing. The 100-call capacity of the recorders and the 48 volt d-c recording operation prevent loss of revenue durin a-c power failures. The use of cold-cathode tubes in th majority of the electronic circuits precludes the frequen changing of tubes since their life depends only on the num ber of on-off operations to which they are subjected. Th *RCA-5823* tubes used have a life of approximately 40 millio operations, a life equivalent to that of most of the othe components of the system.

REFERENCE

1. Fundamentals of the Automatic Message Accounting System, J. Meszar. AIE *Transactions*, volume 69, part I, 1950, page 255.

The Electric System Reliability Required in Petroleum Refining

E. R. FELTON

The reliability required for critical operations is discussed together with some of the design factors which affect this reliability. It is suggested that the automatic secondary selective system, as described here, offers the most economical and generally satisfactory service for critical process units in a petroleum refinery.

THERE IS A definite trend in the oil-refining industry toward large continuous-process units. This trend is being reflected in the industry's electric systems through the demand that they be able to furnish an uninterrupted, reliable source of power for these processes. Electric system failures result in production losses in any industry, but they can be particularly costly in the oil-refining industry because of the close interrelation of most of the continuous-processing units.

The reliability required for process units is determined on the basis of whether the unit is classed as critical or noncritical to the over-all refinery operation as well as the actual operating characteristics of the unit.

CLASSIFICATION OF PROCESS UNITS

SOME REFINERY UNITS are tied together through a processing chain where the satisfactory operation of one depends on the continuous operation of another. An example is a crude-oil distillation unit or "pipe still." This is normally the beginning of the refining procedure where crude oil i continuously separated int various components whic are sent to other units fo further refining. A short in terruption or upset in thi process adversely affects othe units by changing the quality or quantity of their fee streams and it may take considerable time to re-establis normal operation. For the purposes of electrical desig such units are classed as critical and their distributio systems are designed accordingly. The reliability of th distribution system or, in other words, the time require for electrical fault correction, is extremely critical in keep ing all the units involved operating without costly produc tion losses. Other units that fall in this category ar the cracking units, debutanizing and splitting units, ga compression units, and so forth.

An example of a unit considered noncritical from th electrical design viewpoint is the grease plant. Store materials are placed in a kettle for a "1-batch" operatio A power failure during the process means at most lo production for the one unit only and the product may c may not be lost. "Time of fault correction" or reliabilit

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is comparatively noncritical because lost production usually can be made up by later use of spare manufacturing capacity or accelerating the operation. The same reasoning may apply to such refinery operations as blending and loading products, the manufacture of wax, and the chemical-treating plants.

ELECTRIC SYSTEM FOR CRITICAL UNITS

As stated before, the electric distribution system for critical units requires maximum reliability or a minimum time for fault correction. At Baton Rouge it has been concluded that a dual primary, automatic secondary selective system offers the required reliability for a minimum investment. This system is shown in Figure 1. Some of the advantages offered by this type of system are: 1. Faults are isolated and service restored automatically to the unit. No time is lost waiting for personnel to locate a fault and restore service by manual switching; 2. The simplicity of the design makes the application of automatic controls relatively easy; 3. Preventive maintenance is simplified; 4. Normal and spare machines can be split between busses so a complete set of machines is available from a single transformer bus.

The outstanding advantage is the isolation of faults and the automatic restoration of service. Some of the design problems that require proper engineering to achieve this are: 1. Adequate transformer size; 2. The undervoltage protection of motors; 3. Overcurrent protection of equipment; 4. Over-all co-ordination of relays and protective devices.

An improper solution to any one of these problems destroys the reliability of the system. A short discussion of each will show its importance.

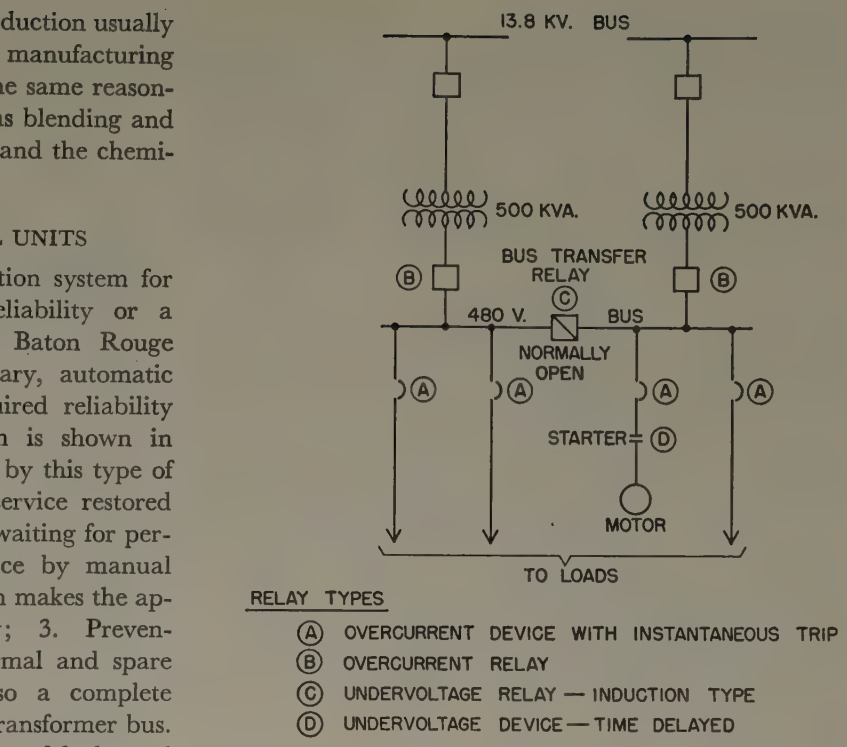


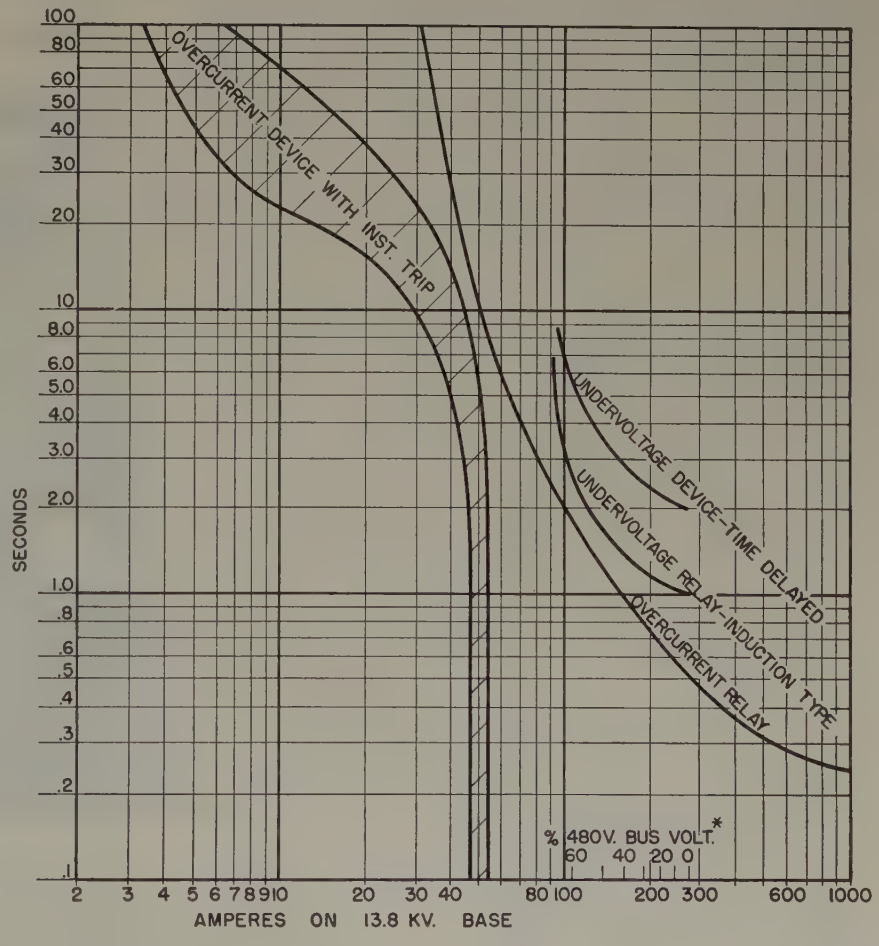
Figure 1. Typical single-line diagram for a critical process unit

DESIGN PROBLEMS

Transformer Size. For an automatic system to be effective, the transfer must be made without tripping out any of the loads. This requires that the transformers be of sufficient size to reaccelerate at least half of the operating motors in a reasonable time without dropping the bus voltage below the minimum "hold-in" voltage of magnetic motor starters. The controlling factor is generally the hold-in voltage and a value of 85 per cent is now considered a minimum.

In many cases designing for this minimum voltage gives excessively large transformer ratings well above that which is required for the total continuous load. Field tests and operating experience will show whether this minimum voltage can be safely reduced to 75 or 80 per cent to obtain better utilization of the equipment.

Undervoltage Protection of Motors. One



* BUS VOLTAGE BASED ON $Z_{source} + Z_{transformer} = 7.4\%$ ON A 500 KVA BASE

Figure 2. Typical relay co-ordination for a critical process unit

of the common occurrences in a distribution system is the tripping of magnetic motor starters as the result of a momentary drop in voltage. This condition has a major effect on the reliability of service to critical units and has led to the use of time-delay undervoltage protection for these motor starters. The amount of time delay normally is determined by the time required for the action of the automatic transfer devices. Some 2 to 3 seconds time delay at zero voltage is usually sufficient.

Overcurrent Protection. The application of overcurrent devices should be limited to the isolation of faults rather than protection against small overloads, except on motors. The damage to transformers and cable from small overloads is usually negligible whereas the loss of several motors will surely be costly in lost production. For example, thermal alarms on transformers can be used to indicate overloads and steps can be taken to prevent serious damage rather than tripping the circuit and possibly causing a complete, unscheduled outage. It is not possible, in some cases, to get overcurrent protection against small overloads and still maintain proper relay co-ordination. In this event, equipment protection is compromised for increased reliability.

Co-ordination of Relays and Protective Devices. To isolate faults with a minimum interruption in service, it is essential that all protective devices be co-ordinated to operate in a planned sequence. Figures 1 and 2 show a typical system and the time-current characteristics of the necessary relays and circuit breakers.

Note that the undervoltage transfer relay *C* is co-ordinated with the overcurrent relay *B* of the main circuit breaker. This allows the main secondary circuit breaker to clear a bus fault before a transfer is initiated, and prevents the closing of the tie circuit breaker through the use of auxiliary relays. Also the undervoltage relays at the motor starters are time delayed behind the transfer relay and the motor circuit breaker to prevent the starters from being tripped by the undervoltage device during a transfer or a secondary feeder fault.

The example shown has been simplified for clarity. In actual application, several circuits are involved and a detailed study must be made of the overcurrent devices offered by different manufacturers to choose those which have the most desirable characteristics. For example a very inverse or extremely inverse induction-type relay has more desirable characteristics for co-ordination with 600-volt circuit breakers than a relay with a standard inverse characteristic.

In addition to the co-ordination of the relays shown for a specific case, this study should be extended back to the primary source. The nature of the source and the other loads connection to it should not be overlooked in setting the relays for maximum reliability.

ELECTRIC SYSTEM FOR NONCRITICAL UNITS

THE ELECTRIC SYSTEM RELIABILITY required for noncritical units varies in degree according to how much production is lost at the one unit if an electrical failure occurs. These systems range from simple straight radial systems to manually transferred secondary selective stations and each has a proper application within its own limitations.

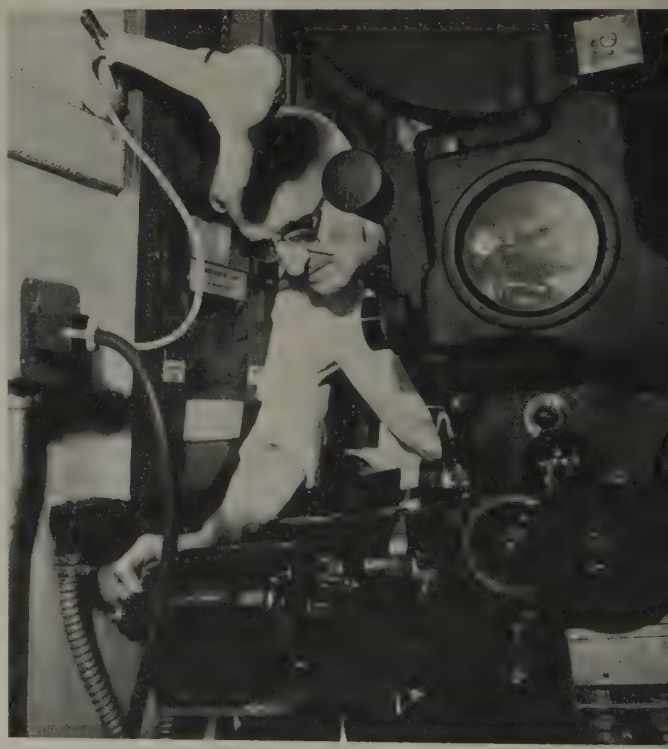
PRIMARY DISTRIBUTION SYSTEM

THE RELIABILITY OF THE secondary distribution system can be no better than the primary distribution system at best. The primary system supplies both critical and noncritical units alike and must be designed for maximum reliability. This design depends on whether the refinery buys or generates its own power and no specific rules can be presented to cover all the acceptable systems possible.

CONCLUSIONS

THE IMPORTANCE OF a reliable source of power to refinery process units cannot be overemphasized. Good judgment on the part of the electrical engineer in choosing the right type of electric system for each process unit and then properly designing it may be the difference between lost production and continuous refinery operation. It is believed that, for critical process units in a petroleum refinery, the automatic secondary selective system, incorporating the features discussed, presents the most satisfactory and economical answer to the problem.

Selsyns Aid "3-D" Projection



A chained selsyn keeps this motion picture projector synchronized with its mate for 3-dimensional projection. Manufactured by the General Electric Company, the selsyn generator is linked to the projector motor by chain and sprockets. The selsyns are powered by an a-c wall plug and are interconnected between the cameras by wall- or floor-mounted wires. Changing from 3-dimensional to standard feature projection is accomplished by merely snapping a wall switch

Studies of Impulse Strength and Testing Problems

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AN EXTENSIVE INVESTIGATION was made covering (1) study of the surge characteristics of windings, (2) determination of the impulse breakdown of insulations, and (3) development of methods for demonstrating insulation levels.

Previous work on alternating and direct voltage endurance of machine insulation was correlated to impulse strength of machine insulation.

Impulse testing conditions were studied on a calculating board and on simulated windings. This study was extended to actual machine windings where low-voltage repetitive surges were applied. A single-turn winding was tested at high voltage wherein 13.8-kv insulation was demonstrated to possess an impulse level in excess of 50 kv.

In the tests the windings were separated at the neutral and the voltage distribution differs from that obtained in service with the windings connected together at the neutral. The following summarizes pertinent observations:

1. The maximum voltage observed in a winding with an ungrounded end terminal may be twice that encountered when the end terminal is grounded.

2. It is possible that seriously distorted voltage distributions may occur within the winding during impulse testing, depending upon the impedance of the terminating resistance.

3. The resultant voltages and oscillations are predictable by calculation-board studies employing lumped constants as the phenomena are similar to those which occur on short transmission lines.

4. The impulse voltage distribution can be predetermined at low voltage on the actual winding by employing repetitive surge testing equipment.

5. Overvoltages during impulse testing due to reflections and oscillations may be avoided through suitable control of test conditions.

6. The wavefront of the incoming test surge voltage should be suitably sloped. The 10-microsecond-front wave appears to be acceptable for test.

7. During impulse tests, the winding should be terminated through a resistance which is reasonably close to the surge impedance of the winding in order to limit the maximum voltage within the winding to the level of the applied voltage.

8. Single-turn coil windings, when terminated in the proper impedance, will withstand impulse voltages 1.25 times the peak of the proved insulation strength of the ground wall.

Recently accumulated test data as to the voltage endurance characteristics of mica insulations used on high-voltage generator windings indicate that the impulse level for the ground insulation of such generator windings is more than 25 per cent above the peak of the 1-minute 60-cycle ASA proof test.

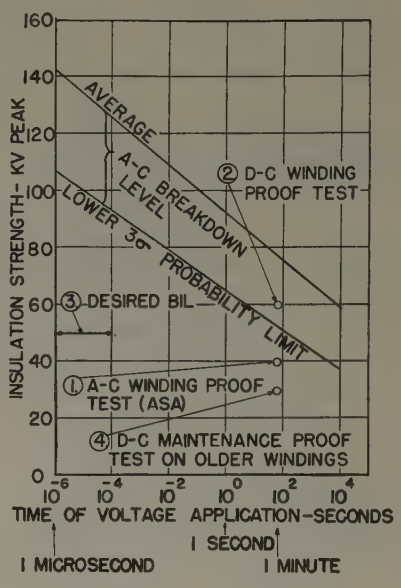

Figure 1. A graphic representation of insulation co-ordination factors for 13.8-kv machines

The use of d-c 1-minute factory tests on high-voltage generator windings at values considerably higher than the suggested 1.25 times the 1-minute a-c test peak value gives ample assurance of the impulse level for the ground insulation of generators (that have been so tested) to ensure co-ordination with surge protection.

Studies of impulse voltage distributions on simulated and actual windings have demonstrated that large high-voltage generator windings with single-turn coils can withstand impulse test voltages high enough to provide assurance of co-ordination with the level of protective devices.

Testing techniques and equipment have been developed which permit predetermination of voltage distribution on the actual winding at low voltage so as to prevent damage to the generator winding due to unforeseen reflected or oscillatory voltages.

The procedure developed for single-turn windings appears applicable to multiturn high-voltage windings and work on this project is now under way.

The industry's experience with large high-voltage windings has been quite favorable, as conventional surge protection has prevented failures from overpotentials. Where failures from surges have come to the attention of the authors, it has been found that there were contributing causes (such as previous damage to the insulation). From this it can be concluded that the present surge protection practices of the industry are satisfactory, and that the currently used insulations possess adequate impulse levels for the type of surge protection used.

Digest of paper 53-11, "Studies of Impulse Strength and Impulse Testing Problems on High-Voltage Generators," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 19-23, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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Principles of Load Allocation Among Generating Units

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The various factors that should control the assignment of generation among power units of a power system are assembled and reviewed briefly here. Whether to use a unit and at what load can be determined satisfactorily only by co-ordinating availabilities and costs of other units, total system load, and interconnection schedules, together with electrical limitations such as spinning reserve, service continuity, voltage regulation, and transmission losses.

WITHIN THE LAST 3 years turbine and boiler manufacturers, as a result of suggestions by AIEE and American Society of Mechanical Engineers committees, have made extensive tests to determine allowable rates of generation change on steam equipment. Methods of determining transmission loss in terms of unit generation have been developed and are being improved and simplified continually. The need for adequate reactive reserve is being recognized, including requirements as to diversity in location and flexibility of control. Telemeters and other fast-acting recorders have permitted continuous totalization of system load and a better appreciation of maximum normal rate of system load change. The universal use of telemetering and load control on interconnected systems has led to a better understanding of the conditions of assignment of generation which provide the most effective balancing with system load requirements.

CURRENT OPERATING PROBLEMS

THERE ARE STILL several items on which more information is needed. It is still not known whether maintenance cost or liability to sudden failure are increased if a unit is operated continuously at wide open throttle. It is not known in any particular case how far, if at all, the manufacturer's factors of safety can be safely encroached on by temporarily increasing steam pressure above rating. There is little information available on the over-all incremental efficiency of boiler, turbogenerator, and auxiliaries at loads between nominal name-plate rating and maximum capability. In fact, there is no generally accepted definition of maximum capability. There is almost no information as to the effect on efficiency of either large or small output variations about a given average output as compared with continuous operation at the same output.

FUEL COST

IT GOES WITHOUT SAYING that one of the major factors controlling the most desirable allocation of generation between units is the total cost of power. The unit cost in cents per kilowatt-hour is a product of plant efficiency as measured in fuel Btu per kilowatt-hour combined with the unit fuel cost in cents per million Btu. Neither of these two factors is as simple as it sounds. It is generally known that when more than one unit is involved incremental rather than averag efficiency must be considere and that minimum over-a cost is obtained when eac unit is working at the sam incremental cost. It is not well understood that incr mental costs apply only steady output condition There are few test data avai able on the cost of changin load rapidly across a narro band as compared with operating at steady load in th middle of the band. Incremental loading theory is based o sustained load following changes and neglects thermal loss or gains during the change process. Tests of both narrow band and wide-band cycling are needed to compare wit fixed output conditions. There is little information abou the additional heat losses in building up to a steady outpu or in backing down from a steady output. Such loss may be important when a large unit's output is change once a day or oftener as compared with the old practice base-loading it except on week ends.

The incremental fuel efficiency of most modern turbin decreases slightly with load until a point near the nomin name-plate rating, above which it decreases rapidly. Th efficiency of most units at maximum capability is sever per cent below the guaranteed value at nominal full loa The boiler efficiency generally is lowered slightly at hig loads. Percentage of station use decreases as the loa increases. The result is that the average station has reduction in incremental efficiency as load increases.

It is becoming generally understood that the total co of power delivered to customers is the proper criteric rather than the total cost of power at the power plant If distribution losses are not affected by plant loadin the delivered cost is composed of three controllable factors

1. Fuel cost at power plant.
2. Other costs at power plants.
3. Transmission loss.

Item 1 is well understood. It is usually obtained on gross basis, and it must be converted to net by prop measurement of station use. This is easy in mode unit-type plants. Item 2 consists of labor and supplies f operation and maintenance. Incremental nonfuel opera

Full text of paper 53-49, "Principles of Load Allocation Among Generating Unit recommended by the AIEE Committees on Power Generation and System Engineer and approved by the AIEE Committee on Technical Operations for presentation at AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953. Schedu for publication in AIEE *Transactions*, volume 72, 1953.

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ng costs are usually estimated averages. Incremental naintenance costs are usually approximated or neglected. nformation on item 3 is available in current technical lata.

Methods are now available for combining fuel cost and ransmission loss and determining by network analyzer tudy or by computing devices, the minimum cost of power lelivered at a substation for any reasonable number of ombinations of generator availability. A fuel and loss o-ordination study gives a means of minimizing with some ssurance the delivered total cost of energy instead of vorking as heretofore with a very rough approximation, iamely the unit cost of energy at the generating plants.

REGULATING REQUIREMENTS

THE PRIMARY REQUIREMENT of a power system is not to operate the plants at the lowest cost but to generate t each moment the exact amount of power required by the ustomers. That particular amount should be generated t the lowest cost, other things being equal. However, ther things are never equal. Service, voltage, and control onsiderations affect both over-all system costs and over-all ystem revenues.

The growth of systems and of interconnections may onceal temporarily the penalties for not "matching" oad and generation. As the system or interconnected roup becomes larger, frequency deviations will be smaller ut harder to correct. If the group is large enough, there vill be no apparent change in frequency for ordinary nbalances in any one system between load and generation. n such cases it is necessary to look at the net interchange ver all tie lines to see whether a system is taking care of ts own obligations. Interconnection does not obviate r reduce the necessity of each system taking care of its wn load changes by its own plants, or of making tech- ically feasible and financially sound arrangements for elp in regulation. Interconnection reduces the required ercentage of spinning reserve, but does not eliminate the ecessity of carrying spinning reserve.

An important danger in parallel operation arises from he ease with which any system can avoid its responsibility or carrying its own load, by generation or by firm contract, y spreading this burden among many unsuspecting eighbors; this will result in poor frequency, erratic ie-line loading, reduced tie-line capability, lowered fuel conomy, and wastage of hydroelectric energy. This azard should be avoided by proper contractual and echnical arrangements for transferring either regulation r a block of capacity in those cases where comparative nergy costs and/or location of capability justifies such ransfer. In such cases the two systems involved require pecial control facilities and practices. There may be some uestion as to whether any system should buy its regulation rom a neighboring system, unless the two systems have nutually inducive financial arrangements, co-ordinated lanning, ties of adequate capacity, and a reliable high- peed channel for net interchange load control. Ex- erience in some areas has shown that the claimed savings re offset in part by technical difficulties and policy differ- nces.

At times of rapid normal load change on a system, such as in the early morning and at noon, the continuous matching of load and generation is not easy, even if there were no economic or technical limitations in the power plants. There is no over-all combination of telemetering, load control, and governing which will reproduce a change in tie-line loading instantly and exactly in turbine output. The main source of nonlinearity is in the turbine governor and in the synchronizing motor which drives it. Some improvements in both of these devices have been made in recent years. Sooner or later there probably will have to be provided linearity by means of a feedback system, as is done in other types of control.

The rate of instantaneous load change is not easy to measure even under normal conditions. The amount of change over several minutes is not too difficult to measure, but for shorter intervals the rate probably varies inversely as the square root of the time interval.

There are fundamentally two different types of customer load changes which must be handled. These types of load change are

1. *Sustained Load Changes.* This type of load change occurs over a period of minutes and when not properly controlled shows up the net interchange chart as a drift away from the scheduled value. This type of change has long been recognized and has been handled satisfactorily with impulse-type telemetering and impulse-type load control. This type of control recently has been developed to a point where it can be utilized by the dispatcher to follow the desired system loading schedule by setting dials in the dispatcher's office, provided he knows the desired generation on each station for each value of system generation.

2. *Fringe Load Change.* This type of load change is not sustained and exists for a minute or so at the most. It is this type of load which causes the characteristic bandwidth on most ties. When this band is of sufficient width to limit the amount of power transfer over the ties, these fringe load changes must be reduced by corresponding generation changes even though they cannot be eliminated entirely. Since the fringe load control must be very fast in its detection of the start of a swing, it cannot be of the impulse type but must be continuous. Similarly the telemetering that transmits this intelligence to the control must be of the continuous type. Consequently, telemetering and control are not separate problems but only different phases of the same problem, necessitating close co-ordination of the two.

3. *Combination Load Changes.* From the over-all operating viewpoint of any one system on which both types of load changes occur, the dispatcher should be able to assign definite percentages of each control response to various stations. For example, one operating requirement might be to maintain constant integrated output of the steam plants over a period of time but to utilize their ability to respond rapidly to fringe load changes. This would be done by the dispatcher setting zero percentage of the control action for absorbing integrated load change but a high percentage of the control action for correcting

fringe load changes. Another practical requirement might be to have the steam plants absorb the sustained load swings while rapid load changes are assigned to hydro stations. The hydro stations then would maintain constant integrated output as might be desired to maintain minimum stream flow, but would respond rapidly to the short-time fringe load swings.

The preferred modern means of getting speed and uniformity of response from system generation is to send the regulating signal to as many stations and units as possible, limited only by the cost of the control channels or the small size of the units involved.

Limitations on the speed of response of steam equipment probably will continue to exist, but these limitations are not as serious as formerly. Until recently the manufacturers had little data on the effects of differential temperature changes on steam turbines. Long ago they set a limit of 1,000 kw per minute with the implication that still slower changes or no changes at all contributed to the reliability and life of the turbine. Recently the manufacturers have found that more rapid changes are permissible and in some cases desirable. The manufacturers now have revised their instruction books for the newer units, permitting a 25-per-cent instantaneous load change after the unit has been on the line long enough to attain normal temperatures.

In a power system operation of any single unit without regard to system requirements may have serious effects on the performance of the system as a whole. The ideal system would have a small and controllable normal margin of operating reserve in every item.

The regulating problem today is primarily one of system operation rather than one of equipment design. Operation at maximum turbine capability usually means that the boiler or some of its accessories are operating wide open, leaving no adjustment to meet normal variations in fuel or weather conditions. A turbine operating wide open is not responsive to system speed drop. Its governor operation is almost negligible, thus forcing other units on the systems to carry the entire burden of regulating frequency or tie-line loading. The response of a single unit varies greatly from one valve point to another, but if several units are used simultaneously for regulation the response is more uniform and approaches the average governor slope. The foregoing are some of the reasons why operation of a turbogenerator continuously at maximum capability increases the cost of other power sources and decreases quality of service.

RESERVE

In addition to the reserve required for regulation, a certain amount will be needed for emergencies. Kilowatt reserve always is regarded as essential. Its location is not too important unless the system has transmission bottlenecks. In some cases kilowatt reserve may be purchased from another interconnected system.

Reactive reserve is a much more serious problem. Generator capability is sometimes limited by availyble transformer taps or by excitation. The system power factor varies seasonally and tends to drop as the syste grows, unless offset by capacitor installations. For thes reasons considerable margin in reactive capability desirable. Excess reactive capability provides about th only margin available to the dispatcher to meet syste emergencies, such as line or generator failures. Th margin should not be used up in normal operation. Som margin of easily available reactive kilovolt-amperes desirable, not only on the power system as a whole but i each area—unlike kilowatt reserve, reactive reserve can not be supplied effectively from interconnections or fro remote sources. Reactive losses in transmission are thre to eight times as great as power losses. Therefore eac load center needs a controllable reactive source at han or nearby. For this reason, generators normally shoul not be loaded to full kilovar capability values.

CAPABILITY

The nominal name-plate rating of a unit in the pas had been established largely for the convenience the manufacturer and the planning engineer, and it ha been found to have little bearing on operation.

The operating department needs two capability rating One is the normal capability which safely can be carrie continually under ordinary operating conditions. Th other is the emergency capability. Both of these must b determined by test and will include both electrical an mechanical limitations in generator, turbine, boiler, fans pumps, and exciter, as effective under annual peak condi tions of power factor, weather, and maintenance need and schedules.

There has been considerable difference between variou definitions of maximum capability. In some cases thi has been the maximum-hour output of record. In othe cases maximum capability has been an ideal figure for th operators to aim at, even if seldom obtainable in practice There is now a growing tendency to define maximu capability as something that can be depended upo under the worst weather and system conditions whic reasonably may be expected. Such a rating will be con siderably in excess of name-plate rating, but it will be les than the maximum capability as determined by test unde favorable conditions.

It is not easy to agree on "the worst conditions whic reasonably may be expected." Owners, planners, de signers, load dispatchers, statisticians, and others may lik to set a plant's capability at the highest possible figur The plant superintendent may like to have a little cushio in capability to fall back on to facilitate normal main tenance, or to allow for inevitable wear, poor fuel quality high temperature of cooling water, low system frequency and so forth. He does not want to utilize regularly cer tain emergency measures which are of only temporar value and perhaps hazardous and expensive, such as raisin steam pressure above guarantee, restricting interstag extraction, shutting down coal crushers, and so forth Such measures should be reserved for extreme emergencie of short duration. The main difficulty in setting emer gency ratings seems to be that the plant and the dispatchin groups do not take each other into their confidence. An

:ation supervisor could understand what happens to a power ystem in case of extreme emergency, if the dispatcher ould tell him, and would admit that such emergencies equire team work—and team work requires instant nderstanding and co-operation by all concerned. There a problem for top management when the system operator nd the station supervisor view each other with mutual spicion.

One solution to the maximum capability problem may e to use a range of figures, covering both favorable and nfavorable conditions. An intermediate figure might e agreed upon for normal forecasting and scheduling of peration. It seems that any figures adopted should be stablished primarily for operating purposes even though ney may not agree with those required by Defense Electric ower Administration, Edison Electric Institute, Federal ower Commission, the State Commissions, the Boards of irectors, and others (compiled by their own rules). Very ecently, there has been some agreement on the following efinition, as applicable to many utility requirements:

Station capability shall be normal maximum net generaon for one hour, measured at generator voltage, obtainble when plant is consuming the usual fuel, with usual eam conditions and normal interstage extraction from rbine, using all turbine and boiler equipment that is naintained in operating condition, and with such equipnent in normal state of maintenance and cleanliness, when enerators are operating at normal voltage, with operating ower factor on the generators as normally imposed by the ystem, this capability to be as determined at time of easonal peak on the system.

CONCLUSIONS

MANY ELECTRICAL AND mechanical considerations have to be reconciled in scheduling system generation. The plant supervisor should be responsible for determining availability, minimum loads, maximum loads, permissible rates of output change, efficiencies, fuel costs, and other technical problems of operation and maintenance. Whether to use a unit and at what load can be determined satisfactorily only by the load dispatcher considering availabilities and costs of other units, total system load, interconnection schedules, and various electrical limitations including spinning reserve, service continuity, voltage regulation, and transmission losses. This co-ordination cannot be accomplished by giving control of one of these factors to a separate department. The load dispatcher should dispatch the load, not just operate the transmission switches.

REFERENCES

1. Economy Loading of Power Plants and Electric Systems (book), **M. J. Steinberg, T. H. Smith.** John Wiley and Sons, Inc., New York, N. Y., 1943.

2. Total and Incremental Losses in Power Transmission Networks, **J. B. Ward, J. R. Eaton, H. W. Hale.** AIEE *Transactions*, volume 69, part I, 1950, pages 626–32.

3. Analysis of Total and Incremental Losses in Transmission Systems, **L. K. Kirchmayer, G. W. Stagg.** AIEE *Transactions*, volume 70, part II, 1951, pages 1197–1205.

4. Co-ordination of Fuel Cost and Transmission Loss by Use of the Network Analyzer to Determine Plant Loading Schedules, **E. E. George, H. W. Page, J. B. Ward.** AIEE *Transactions*, volume 68, part II, 1949, pages 1152–63.

5. Transmission Losses and Economic Loading of Power Systems, **L. K. Kirchmayer, G. H. McDaniel.** *General Electric Review* (Schenectady, N. Y.), October 1951, pages 39–46.

6. Analysis of Losses in Interconnected Systems, **A. F. Glimn, L. K. Kirchmayer, G. W. Stagg.** AIEE *Transactions*, volume 71, part III, October 1952, pages 796–808.

7. Evaluation of Methods of Co-ordinating Incremental Fuel Costs and Incremental Transmission Losses, **L. J. Kirchmayer, G. W. Stagg.** AIEE *Transactions*, volume 71, part III, 1952, pages 513–21.

8. Intrasystem Transmission Losses, **E. E. George.** AIEE *Transactions*, volume 62, 1943, pages 153–8.

Integration of Bad-Weather Landing Aids Recommended by ICAO

Ways to improve co-ordination of the varied radio, adar, and visual aids used to help pilots land safely in bad eather have been recommended by an air navigation conrence held in Montreal, Quebec, Canada, by the Interational Civil Aviation Organization (ICAO), an agency f the United Nations.

Technicians representing 25 nations and 4 international rganizations spent 4 weeks examining as a related group any individual air navigation problems in the fields of ir traffic control, aircraft operation, meteorology, badeather landing aids, and communications.

The conference was described by the chairman, G. J. Varcup of the United Kingdom, as a "new type of techical forum designed to knock away the partitions between me of the pigeonholes of aviation techniques."

Reviewing the conference, Mr. Warcup said: "There an be little doubt that the experiment proved a success. his was evidenced, for example, by recommendations ade on the integration of bad-weather landing aids such high-intensity approach lighting systems, radar systems, nd electronic blind-landing devices."

The integrated study was made possible by the joint efforts of experts from many widely differing technical fields.

The ICAO conference devised a new and simplified version of in-flight reporting which permits plain language transmission without requiring the pilot to use complex coding processes.

The conference examined the problem of landing aircraft under poor visibility conditions with an acceptable degree of regularity. It recommended certain improvements in the location and adjustment of elements of the instrument landing system. It also provided for a better co-ordination of radio, radar, and visual aids.

The use of radar in air traffic control is still in its experimental stages. The conference defined the air traffic control requirements for radar equipment and discussed the technical aspects of different types of radar systems. The purpose of using radar for air traffic services is to provide greater flexibility in directing the movements of aircraft thereby expediting landings and take-offs.

Other actions included further development of the ICAO instrument-approach-to-land procedures, agreement on a standard holding pattern for aircraft awaiting their turn to land, and study of visibility at airports.

Operation Problems of Air-Turbine Accessory Drives

T. E. ABRAHAM

The air-turbine motor is a highly significant and necessary advancement in methods of accessory drive. As it is in the developmental stage, there are many problems involved in its use and they probably will increase in number. However, it provides an important means of decreasing aircraft weight and complexity.

THE RECENT development of the air turbine as a means of aircraft accessory drive has provoked the controversy which often accompanies any change in established methods. On one side there is a tendency to proclaim the air turbine as a cure-all for the problems involved in obtaining accessory power. On the other, it has been condemned on the basis of inefficiency and the difficulty it presents in obtaining satisfactory operation under some flight conditions. The latter viewpoint may have been fostered in part by recent studies in which the air turbine was considered to drive only a single generator and did not include all the advantages obtained by this means of accessory drive.

This article is a presentation of experiences to date with an air-turbine drive; the reasons for selecting an air turbine over other methods of drive; problems encountered in selection, and the methods of solution of these problems. The object of this discussion is to aid the engineer in obtaining a realistic view of the air-turbine motor as a method of accessory drive.

ADVANTAGE OF THE AIR-TURBINE DRIVE

As a result of the increasing emphasis on the battle against weight, the electrical engineer is called on to supply more and more power out of each pound of airplane weight charged to him. The major step which can be taken in this direction is the use of a controlled-speed mechanism to drive the power-generating equipment allowing much closer design of this equipment and making available the functional advantages of controlled-frequency alternating current. The problem is not one of using this power but of producing it, and thus the solution lies not alone with the electrical engineer but also with the mechanical engineer. It is the latter who must provide a means of generator drive which will maintain the frequency within sufficiently narrow limits to allow optimum design of electric equipment and components.

Until recently, there have been two basic methods available for obtaining constant frequency: (1) the motor-generator or inverter, and (2) the hydraulic transmission driving from the engine accessory-gear train. With the advent of the jet engine and the attendant availability of high-pressure air from the engine compressor, a third method of constant-speed accessory drive became apparent: the air-turbine motor.

Accessory drive accommodations on the engine are inherently compromised by the necessity of maintaining engine interchangeability between air frames. In order to provide for this interchangeability, the number of drive pads and their power requirements will be designed to satisfy a maximum and will thus place a weight penalty on those air frames not requiring this maximum. The air turbine, as a separate piece of equipment, avoids this weight penalty as it may be tailored to fit each aircraft model's requirements. This does not necessarily mean a complete new design in each case. The tailoring will probably be confined to the gear train and to speed changes of the turbine wheel.

In a multiengined aircraft, the air turbine may be placed close to the load center of the airplane thus eliminating the main power transmission lines normally running from the engines to the fuselage. This not only results in a major weight saving and in localization of service trouble but can result, because of the high cost of designing, developing, and installing electric and hydraulic lines, in a substantial saving in system cost. Somewhat offsetting this is the fact that an air duct must be provided from the engine to the unit; but, as the existing air-conditioning ducting may be used, with slight enlargement, the penalty is generally small.

One of the recent studies of the use of air-turbine drives has been made on the basis of supplying electric power only and presents a very pessimistic outlook for the drive unit from the weight standpoint. Actually, in the investigations discussed herein, the main weight advantage was accrued through the use of the turbine to drive the airplane hydraulic pumps. The reason for this lies in the

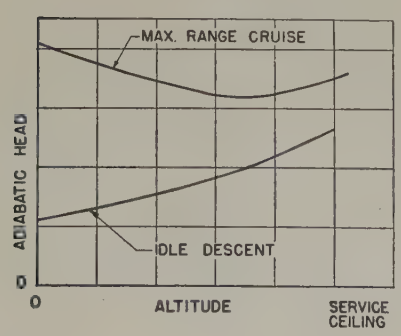

Figure 1. Bleed-air-power availability for two critical flight conditions

Special article recommended for publication by the AIEE Committee on Air Transportation.

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elimination of the engine-to-fuselage distribution lines which were of large size because of the length of run and the low temperatures at which the system had to operate.

An evaluation of the installation weights and the effect on engine performance with the accompanying fuel penalty for the constant-speed hydraulic drive and the air-turbine drive showed a weight advantage for air-turbine drive of approximately 75 pounds.

VARIABLES AFFECTING TURBINE POWER OUTPUT

Since the air turbine derives its power through the expansion of air bled from the engine compressor, the maximum power output is a function of the power available per pound of compressor bleed air. This has been termed adiabatic head and is the power which can be extracted from the air at 100-per-cent air-turbine efficiency. As it is a function of the compressor-bleed-air pressure and temperature, which are directly related to engine thrust, the adiabatic head will vary with the engine thrust condition. Since it gives a measure of available power, the adiabatic head is one of the primary parameters used in setting the design point of an air-turbine motor. Typical curves of adiabatic head for the two flight conditions of cruise and idle descent are shown in Figure 1.

The second parameter fundamental in determining the power available at the accessory drive pad is the efficiency of the turbine itself. A typical curve of the variation of the efficiency with the pressure ratio is shown in Figure 2. The characteristic shape of this curve is a slight negative slope above the optimum design point and a sharp drop off to zero below this maximum. This drop off is caused by the fact that the exit velocity from the nozzles is approaching the effective wheel speed. Thus the efficiency curve may be shifted by changing the operating speed of the turbine.

It is obviously desirable to set the turbine to operate at maximum efficiency during cruise. The degree to which this is attainable is limited by the power requirements at the lower pressure ratios. If a drive unit is designed to give maximum efficiency for long-range cruise operation, it can be seen in Figures 1 and 2 that the power availability will be markedly decreased under conditions of idle descent and, more important, landing approach. If a landing approach is considered in which the throttle is held in an idle-stop position, the maximum power obtainable from the drive unit will vary with airplane speed and with drive unit speed as shown in Figure 3.

It has been stated in a previous paragraph that the air-turbine power will be a function of the engine power. Thus the turbine output may be raised by increasing the idle setting, as shown in Figure 4. Also, since the engine power is markedly affected by the ambient temperature conditions, the power available from the air turbine also will vary with ambient temperatures. Figure 5 compares the maximum output at temperatures of −67, +60, and +100 degrees Fahrenheit.

One of the major problems in the design of an air turbine is that of providing power at the low-pressure ratios available when the airplane is descending from high altitude with the engines throttled back to idle. The importance

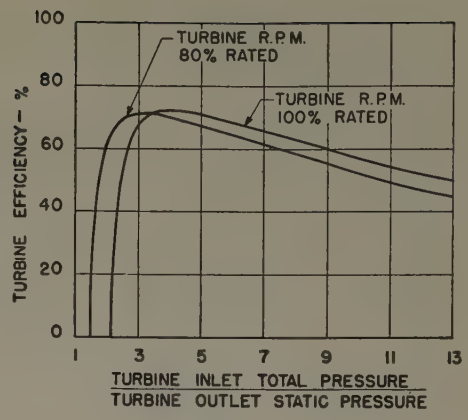


Figure 2. Turbine efficiency as a function of pressure ratio

of this flight condition as a basic design criterion is determined by the idling schedule of the engine. The idling schedules initially presented for some of the advanced engines were such as to make the idle descent the basic design limitation for the air turbine. It has been found recently, however, that in order to alleviate engine operational problems such as flame-out, the altitude-idling schedule had to be greatly increased over the original estimates. Thus the idle descent from altitude is not the critical design point as initially thought. This is demonstrated in Figure 6, which shows the power available as a function of per cent frequency with varying altitudes for the condition of stall speed with engines idling. The trend here is definitely toward better frequency control as the altitude is increased; and, for the case in question, points up the landing approach as the critical flight condition involving an idling engine.

DETERMINING THE POWER REQUIREMENTS

In setting up the power requirement schedule, the engineer should avoid the pitfall of attempting to provide drive power to supply the airplane needs with all equipment operating simultaneously in all flight and ground conditions. Much of the equipment has an intermittent duty schedule and the improbability of these items operating at one time must be considered.

In the selection of an air-turbine-drive unit, it is mandatory that a realistic approach be made in the determination of the power requirements. In general, there are four basic conditions which must be examined. These are

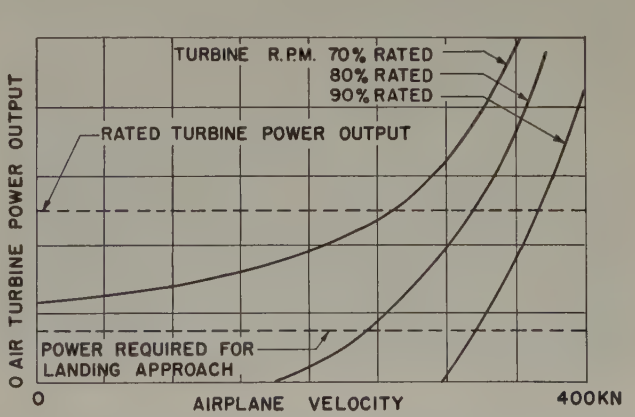


Figure 3. Effect of turbine speed on power output with engines idling

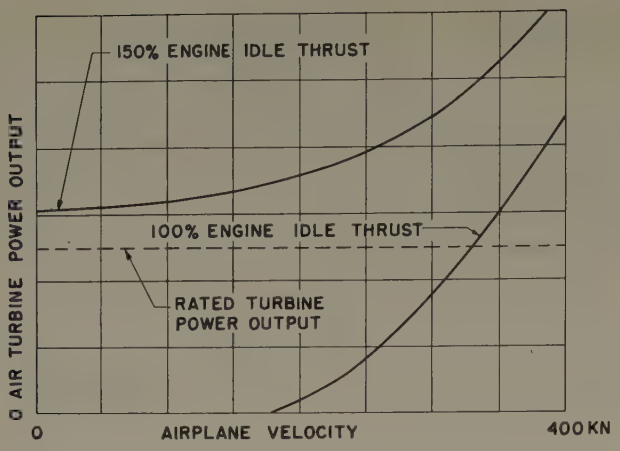


Figure 4. Effect of engine idle thrust on power output: 80-per-cent rated air-turbine rpm

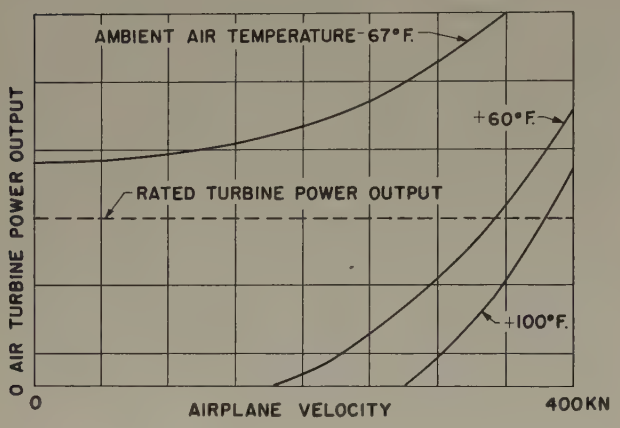


Figure 5. Effect of ambient air temperature on air-turbine power output: 80-per-cent air-turbine rpm engines idling

cruise, combat, descent, and ground operation. For a typical case, the power as a per cent of available accessory output (rating) ran approximately 40 per cent for cruise, 85 per cent for combat, 30 per cent for letdown and landing. The allowance that must be made for growth of power requirements is another factor which must be taken into account in the selection of an air-turbine motor. This is a factor which must be evaluated in terms of the requirements of the services and in accordance with the experience of the air-frame manufacturer.

EFFECTS OF UNDERSPEEDING THE TURBINE

As shown in Figure 3, the power output of the turbine can be greatly increased by allowing the drive unit to underspeed. The allowable speed reduction is dependent upon the effects of that speed reduction on the driven accessories. In hydraulic equipment the only effect is to increase the operating time, and is not detrimental to airplane operation.

In the case of electric equipment, however, operation at frequencies either above or below rated can be very harmful to the equipment. In a survey of the effects on various items of electronic equipment used on a particular airplane, it was found that the a-c electric motors examined were operable over a fairly wide frequency band. T cite an example, the variation of current with frequency f the electric-driven fuel pump tested is shown in Figure and shows approximately 80-per-cent current increa when the frequency is dropped to 75-per-cent rate It was felt by the motor manufacturer that the heatir caused by this increased current would not be harmful f the short period of time required for operation at th condition.

It should be noted that the foregoing discussion pr supposes the existing prevalent control system in which th voltage is held constant while the frequency is allowed vary. The adverse effects on the motors caused by unde frequency operation can be alleviated, in most cases, b allowing the voltage to vary with the frequency. Thi however, is unsatisfactory as it entails an additional syste to supply equipment requiring constant voltage.

Of the electric equipment examined, the items whic were found to demand the closest frequency control we those entailing the use of transformers. Equipment of th type generally may be classified in the two categories instruments and communications. For one specific piec of communication equipment, it was found that operatio below 380 cycles was hazardous even for the short tim that would be encountered during landing approac Figure 3 demonstrates that a reduction in frequency about 300 cycles per second is required in order to insu adequate power from the air-drive units during approach

Therefore, although most of the articles examined cou tolerate a substantial frequency reduction for short period

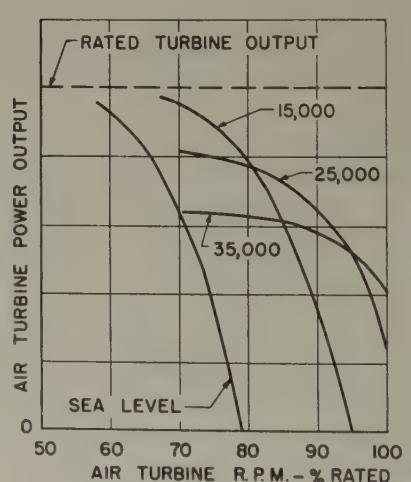


Figure 6. Effect altitude on air-turbi power availability: e gine thrust 150 per ce normal idle

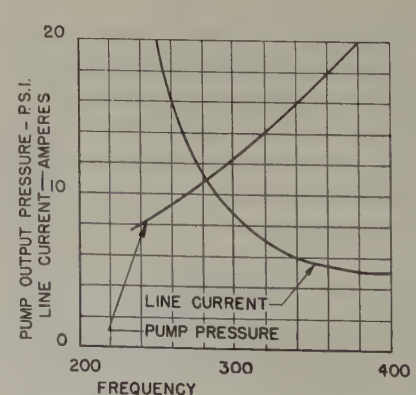


Figure 7. Effect of fr quency on current f an a-c fuel pump oper ing at low fuel flo Frequency is in cyc per second

the limitations imposed by the communications equipment precluded the use of turbine underspeed as a means of obtaining power at low-pressure ratios.

SOLUTIONS TO PROBLEM OF EQUIPMENT DAMAGE AT LOW FREQUENCIES

IT IS POSSIBLE THAT those components which are seriously affected at low frequencies could be redesigned to eliminate this characteristic. This loses the main advantage of controlled frequency since it entails a large increase in component weight. In all probability it would destroy interchangeability, as each manufacturer would desire that the components be tailored to meet his limits.

A second method of obtaining power at low-pressure ratios is the use of design compromises in the air turbine. Figure 2 shows the effect of changing the wheel speed of the turbine. Note that although the power availability at low-pressure ratios is greatly increased, the point of maximum efficiency is shifted so that it no longer coincides with the pressure ratios incurred in cruising. Also, the basic size of the turbine itself must be increased in order to maintain the required output of the unit, thereby greatly increasing the weight.

Another method of obtaining the same results, is by the use of a gear shift which would allow the use of lower turbine wheel speeds for the landing approach condition. The disadvantage of this method lies mainly in the increased complexity of the unit and control system.

By far the simplest solution to the problem is landing at an increased throttle setting which holds up speed but causes an increase of thrust on the airplane. This increases the adiabatic head available to the turbine and thus turbine output. Whether the increased thrust can be tolerated is a function of the airplane flight characteristics. A summary of the approach parameters of a given airplane as a function of engine thrust is presented in Figure 8. This demonstrates that the thrust which can be tolerated on landing is fairly high for this airplane; an increase of the idle thrust from zero to 15 per cent military results in an increase in approach distance for 1,000 feet decrease in elevation of 50 per cent. In this respect some classes of military aircraft enjoy a definite advantage in that the effects of increased throttle setting can be more than offset by the use of speed or dive brakes.

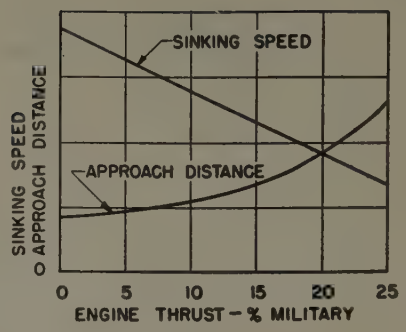


Figure 8. Effect of engine thrust on airplane approach parameters

In the latter method, the effect on wheel-brake wear should be examined. As the required increased idle thrust is generally more than that required for taxiing the airplane, the brakes will be used continuously during taxi to control speed. Examination of a particular example showed that with an idle setting of 20 per cent of military rated thrust, 90 miles of taxi distance at 40 miles per hour was the equivalent to 100 rated energy stops. Since the advanced thrust requirement is considerably less than the foregoing, it was felt that the increased brake wear was of little consequence.

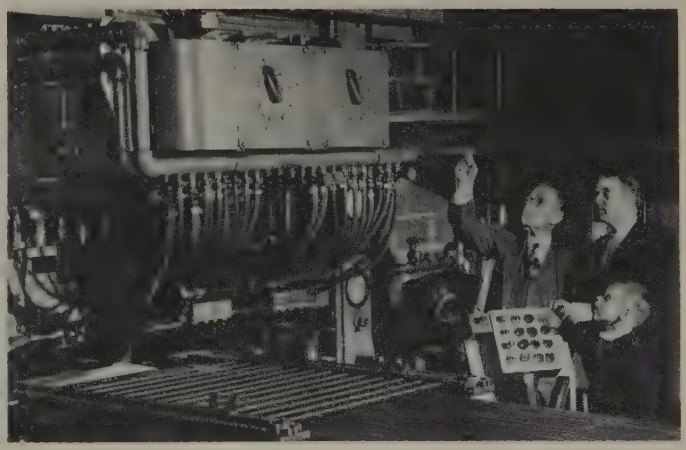
Thus, the air-turbine motor is neither panacea nor pitfall but is a highly significant and necessary advancement in methods of accessory drive in the development stage. As such, the problems attendant to its selection and use are probably just beginning. It is not a piece of equipment which will find application in every air frame; but it does provide the aircraft engineer with a powerful weapon in his never ceasing battle against airplane weight and complexity.

Automatic Welding Machine Makes 62 Simultaneous Welds

A new automatic welding machine, just put into operation at the Irving Subway Grating Company, Long Island City, N. Y., does the work of dozens of human welders in a single stroke. It makes 62 simultaneous welds, or a total of 744 per minute. This represents 24 square feet of welded grating a minute, or 1,500 square feet an hour. The process is completely controlled by instrumentation by a single operator.

During the multiwelding process, pressure for forging the bearing bars with the cross bars is equivalent to 100 tons. Welding temperature is approximately 2,000 degrees Fahrenheit. The machine has its own water tower, with self-circulating system, for cooling transformers and conductors. Some 400 gallons of water per minute are used in the machine.

Welds can be made at desired spacing points for grating openings of different sizes.



Giant welding machine is started in operation by grandson of founder of Irving Subway Grating Company, while his father and grandfather (left) stand by

New Line of Low-Voltage Air Circuit Breakers

B. S. BEALL, III
MEMBER AIEE

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A NEW LINE OF AIR CIRCUIT breakers, having interrupting ratings of 50,000, 75,000, and 100,000 amperes, has been developed to meet the requirements of modern low-voltage electric systems.

Three frame sizes of the new line of breakers with electrical operating mechanism and equipped for drawout mounting are shown in Figure 1. These breakers have new short-time ratings and close-and-latch ratings, which are equal to the interrupting ratings. All three of these breakers have the same height and same depth dimensions and vary only in width. The 1,600-ampere size is designed also with a manual closing mechanism.

The multislot interrupters used on these low-voltage breakers interrupt the arc by dividing the current into multiple parallel arcs and by lengthening and cooling the arcs in narrow slots formed by perforated separating plates of phosphoasbestos. This efficient type of interrupter gives effective utilization of space and breakers of reduced size.

The design gives easy access for maintenance as the breaker can be separated into two parts, mechanism and back frame, without disturbing any control wiring or mechanism adjustments. The back frame has individually insulated poles, with multiple contacts for each phase. A new type of linkage maintains a fixed relationship between the moving arcing contacts and the main contacts, which is not affected by short-circuit stresses. The stationary contacts are spring loaded and located so that the magnetic force from short circuits increases the contact pressure. These design features are important in obtaining improved short-time and closing ability.

The electrically operated circuit breakers are equipped with a stored energy closing mechanism having the required closing ability which is independent of continuity of the control power source. In addition, the control power requirements have been reduced to a practical minimum and for the largest breaker 4 amperes at 115 volts, 60 cycles alternating current is required. Through a system of reduction gears and over-running ring gears, small universal motor charges the closing spring with a the energy required in the closing operation. Release the closing force is accomplished by running the chargin cam over dead center, which produces an arcing conta speed of approximately 10 feet per second. Although th mechanism must develop sufficient force to close again short-circuit currents, its design gives retardation an partial recharge of closing springs under no-load operatio After the breaker closes and the control closing switch released, the motor recharges the springs for the next closin operation.

There are two types of overcurrent trip devices. series coil device is used for the 1,600-ampere frame whic is interchangeable for ratings between 15 and 1,60 amperes. For higher ratings, 2,000 to 4,000 ampere a magnetic structure is placed around the breaker stu which constitutes a single turn coil for operation of th timing elements. Each type is available as a 3-elemen 2-armature device, which is capable of performing an combination of the three following functions: (1) long-tim delay tripping, (2) short-time delay tripping, and (instantaneous tripping.

Short-time tests of 30-cycle duration were made with th current equal to the interrupting rating with no weldin no change in physical appearance, and no change i electrical performance of the contacts. Also, two forms duty cycles were performed at full rating on this line breakers. These were (1) open—2 minutes—close an instantaneously tripped, and (2) open—2 minutes—clos and delay tripped. The latter test demonstrates clos and-latch ability for selective systems application. Min mum size enclosures used in tests presented a metall grounded surface $1^5/_{16}$ inches above the 27-inch height the breaker base. The total short-circuit duration of th breakers equipped with instantaneous tripping is 3 to cycles, depending upon the size of the breaker.

The design of the new line of circuit breakers has com bined a new means of contact ope ation and the stored-energy mech nism with the multislot interrupt to give short-time rating and clos and-latch rating equal to the inte rupting ratings. It gives great increased ability on repetitive-du applications to meet the starti duty of large low-voltage a-c moto

Figure 1. Three electrically operated air circuit breakers rated 4,000, 3,000, and 1,600 amperes (from left to right). Breakers shown are equipped for application in drawout switchgear

Digest of paper 53-149, "New Line of Low-Volta Air Circuit Breakers," recommended by the AI Committee on Switchgear and approved by AIEE Committee on Technical Operations for pr entation at the AIEE Winter General Meeting, N York, N. Y., January 19–23, 1953. Not schedu for publication in AIEE *Transactions*.

B. S. Beall, III, and V. N. Stewart are with General Electric Company, Philadelphia, Pa.

Boiler Designs Developed for Controllability

P. R. LOUGHIN

OPERATION OF A CENTRAL-STATION steam-generating unit requires continuous automatic control of water level, steam temperature (both high-pressure and reheated steam), and drafting equipment. Modern boiler designs have features which facilitate automatic control.

A tremendous stride in water level control was made by development of the cyclone steam separator. Converting some of the energy of circulation into centrifugal separating force, this device not only separates water from steam so that high-quality low-solids-content steam is delivered to the turbine, but also separates steam from the boiler water so that steam-free water is supplied to the boiler downcomers, thereby reducing water level fluctuations when steam pressure or boiler load changes. Furthermore, it permits high-quality steam to be maintained despite wide variations in water level. The burden on water level control equipment thus is reduced, and control simplified.

Accurate control of steam temperature is important in maintaining high plant efficiency while protecting equipment from excessively high temperatures. Increased fuel costs and the need to operate even new equipment at partial loads have put increasing emphasis on the attainment of design steam temperature over a wide range in load. The revival of the reheat cycle has added another steam temperature which must be controlled, with the further complication that the distribution of heat absorption between superheater and reheater varies with load. Variations in operating conditions, such as furnace wall cleanliness, also must be accommodated. A number of different methods of providing steam temperature control have been developed, including spaced burners, spray attemperators, submerged attemperators, gas flow proportioning dampers, flue gas recirculation, and furnace wall blowers. In most installations two or more of these methods are combined to produce the required high-pressure and reheated steam temperatures over the desired range of load and operating conditions.

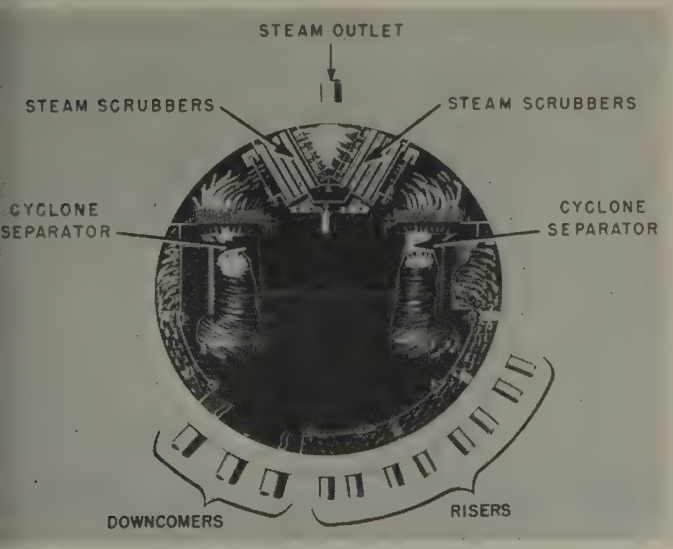

Figure 1. Cyclone steam separators

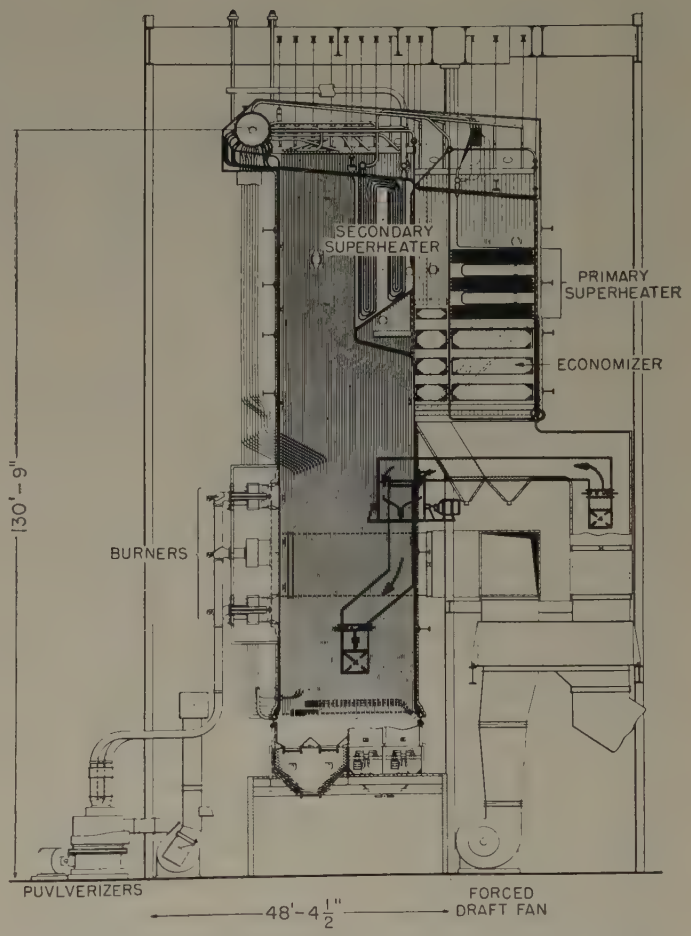

Figure 2. Gas recirculation for steam temperature control

The complexities of controlling two sets of fans (operating in series with each other), so that the correct combustion and furnace draft conditions are maintained at all times, have been simplified by the development of central-station boilers with gastight casings for operation under pressure. Furthermore, elimination of air infiltration into the boiler setting reduces the total quantity of gas to be handled, as well as reducing the draft loss through the unit. The induced-draft fan may be omitted entirely, or furnished for intermittent use under special conditions. The forced-draft fan handles only clean, cold air, and requires less power than a combination of forced- and induced-draft fans. The maintenance of the induced-draft fan, which handles hot, dust-laden gases, essentially is eliminated.

Digest of paper **53-140**, "Boiler Designs Developed for Controllability," recommended by the AIEE Committees on System Engineering and Power Generation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953. Not scheduled for publication in AIEE *Transactions*.

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The Nickel-Base Indirectly Heated Oxide Cathode

A. M. BOUNDS P. N. HAMBLETON

The present status of the barium-oxide indirectly heated oxide cathode is reviewed from the viewpoint of the electronics engineer. Emphasis is placed on the role of the cathode alloy as well as some of the possibilities and shortcomings of this cathode in the commercial electron tube.

THE BARIUM-OXIDE indirectly heated oxide cathode came into wide use in 1927 and since has virtually dominated the field of ordinary receiving tubes and many other special types as well. The oxide cathode is perhaps the least understood element in the modern electron tube, and indeed its functioning may be the least understood phenomena in the entire science of electronics. It certainly is a credit to the electronics industry that so much has been done in the application of electron tubes without a complete understanding of exactly how the electron current is produced in the first place. Research work on oxide-coated cathodes is a highly specialized and complex undertaking. The very large number of variables, the many steps necessary to construct experimental tubes, and the difficulty in exact reproduction of these devices have restricted research to a very limited number of laboratories. Perhaps not more than a few dozen scientists in the entire world have directed intensive and long-continued study to the oxide cathode. One of the earliest and most penetrating papers dealing with both the cathode base metal and its relation to the oxide coating was presented by Benjamin[1] in 1935. Further, and more detailed information has been developed by Sproull,[2] Eisenstein[3] and his associates in this country, and by Herrmann and Wagener[4] in Germany, Loosjes and Vink[5,6] in Holland, Violet[7] in France, and D. A. Wright[8] in England.

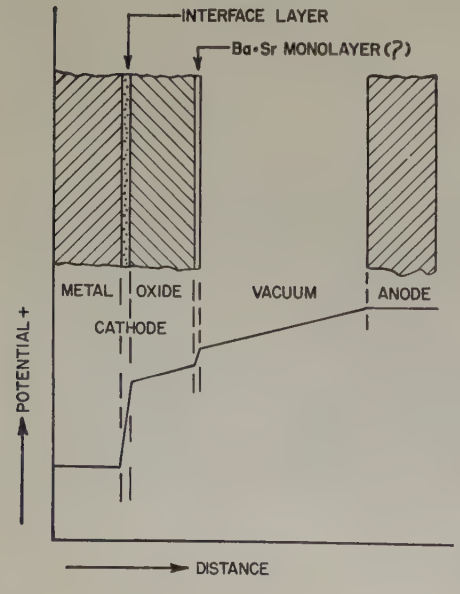


Figure 1. Schematic view through a diode tube with potential distribution approximation

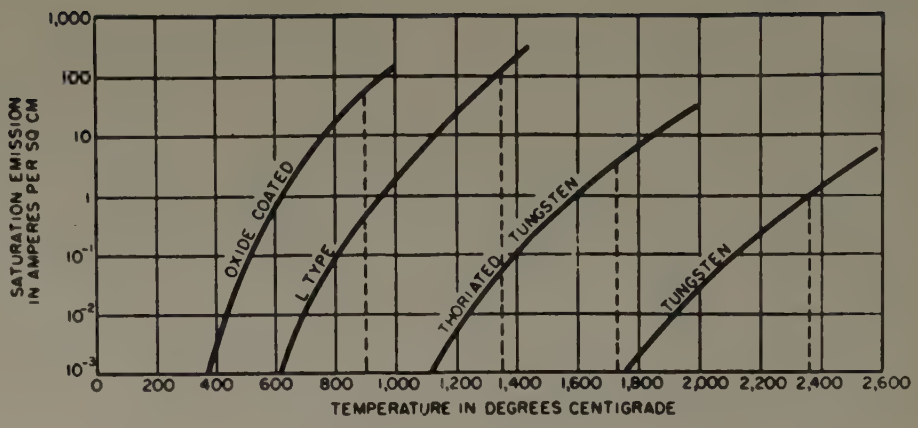
The oxide cathode has be spoken of as an element the electron tube, and so usually is considered by tu engineers. It really is a co plex system composed of metal cylinder or sleeve a a coating of alkaline eart metal carbonates initially held in place by a nitrocellulo binder. These carbonates of barium, strontium, and som times other additives must be carefully controlled as shape, size, purity, and composition ratio. By a combin tion of evacuation and heating the carbonates are co verted during tube processing to an adherent coating oxide crystals, while the decomposed nitrocellulose bind and the carbon-dioxide gases are withdrawn as they a generated. A carefully controlled schedule of hig temperature heating, lower-temperature aging, and actu cathode current drain is required to complete activatio This process is designed to produce an optimum a stabilized electron emission from the cathode.

The precise nature of all the chemical and physic changes which occur on the coating, within the coatin and between the coating and the metal sleeve long h been the subject of speculation. An early theory he that activation was a result of electrolytic action with the mixed oxide coating, but it was not understood th that the so-called pure nickel base metal contained r ducing agents which also entered into the reaction. Late it was believed that a monolayer of free barium and stro tium was formed on the outer surface of the oxide coatin and that barium impurity centers were distributed with the coating as well. Gradually the concept of the oxi coating acting as a semiconductor received considerab acceptance. More recently Loosjes and Vink have a vanced a dual emission mechanism of pore conduction an explanation of current passage through the coati resulting in liberation of free electrons upon the applicati of a suitable positive external field. This theory is findi increasing support at the moment.

In any event, it is generally conceded that the low wo function of elemental barium and strontium in the oxi cathode provides for the release of a copious flow of el trons which are delivered to the anode when a suitab positive potential is applied. Figure 1 is a schema

Full text of paper 53-174, "The Nickel Base Indirectly Heated Oxide Cathode Review," recommended by the AIEE Committee on Electronics and approved by AIEE Committee on Technical Operations for presentation at the AIEE Wi General Meeting, New York, N. Y., January 19–23, 1953. Scheduled for publica in AIEE *Transactions*, volume 72, 1953.

A. M. Bounds and **P. N. Hambleton** are with the Superior Tube Company, Norristo Pa.



igure 2. Saturation emission as a inction of true temperature for L-ithode and three other types. Verti-l dotted line indicates maximum oper-ing temperature for each cathode. his situation can be realized under oth pulse and d-c conditions for all ithodes except the oxide-coated, whose d-c emission is limited

iew through a diode showing an approximation of the otential drop when the cathode is emitting electrons to ie anode.

For many reasons the oxide cathode is most widely used. t is a cheap and versatile mechanism, able to provide everal hundred milliamperes of direct current for short eriods, lower currents for as much as 100,000 hours, and igh pulse currents (tens of amperes) depending on tube esign, care and control of manufacturing processes, oating materials, and techniques and choice of metallic eeve alloy. A comparison of typical emission-current urves for oxide cathodes, tungsten, thoriated tungsten, nd the *L* cathode are shown in Figure 2 which is taken om "New Cathode Design Improves Tube Reliability" y D. R. Hill of Phillips Laboratories.[9]

Just as the oxide cathode is not a single element, but ather a whole system, so the characteristics of an in-irectly heated oxide cathode may be separated into istinct categories, particularly with reference to the base ietal alloy on which the cathode is built. These per-ormance characteristics are admittedly interdependent to degree, but are sufficiently distinct to have real meaning. Cathode performance characteristics well worth careful ttention are

1. Rate of activation.
2. Emission levels, direct current and pulsed.
3. Rate of sublimation at a given operating tempera-ire.
4. Tendency to form interface compounds of high ectrical impedance.
5. Life characteristics:
   A. Rate of free barium production and its influence upon grid emission.
   B. Maintenance of primary emission as it contributes to maintenance of plate current and mutual conductance.
   C. Maintenance of pulsed emission.
6. Heater-cathode leakage currents.

Coating and processing materials and techniques are xtremely variable since each engineer in each tube plant as his own favorite materials and schedules. These are lso dependent upon the equipment and tube types pro-uced in the particular plant. Consequently, these phases hich are still a mixture of art and science will be touched pon lightly. The discussion will center on the nickel cathode alloys which are most familiar and concerning which more is known with certainty.

How does the base metal affect these performance characteristics? The chemical reduction of earth metal oxides by elements contained in the nickel sleeve has been mentioned. With one or two exceptions all cathode nickels contain controlled amounts of one or more of the elements magnesium, silicon, titanium, aluminum, carbon, and tungsten as chemical reducing agents for the alkaline earth-metal oxide coating. These may vary from as little as 0.01 per cent to as much as 4 per cent or more. When it is considered that these alloys are melted in heats of from 700 to 20,000 pounds, the control of such small but important additives is evidently difficult and exacting. Each element and the various combinations of these elements affect the performance characteristics in different ways. While the effect of these elements may not be the only cause of the reduction of free barium, nevertheless the presence of the various reducing agents in the nickel is easily demonstrated to have a profound effect on the performance characteristics of the cathode. Thus, the choice of proper cathode alloy for particular characteristics is more important than commonly understood.

THE REDUCING ELEMENTS

In such a short summary it is not possible to review all of the major and minor effects of each of the chemical elements present in cathode nickel alloys, so only the most important and significant ones will be considered. Perhaps it should be explained first that there are a number of neutral and a few definitely poisoning elements either unavoidably present, or present for metallurgical reasons, which must be kept to reasonably low limits. The important ones are manganese, iron, copper, lead, boron, sulphur, and phosphorus. These will not be considered here.

1. *Magnesium* is the most common and important, as well as the most active, of the reducing agents. It is present in minute amounts in most of the cathode alloys and has the property of promoting rapid activation and of continuously generating free barium and strontium as they are evaporated from the surface of the oxide coating or are chemically combined to become again inactive. On the other hand, magnesium possesses a high vapor

Table I. Commercial Cathode Alloys in Common Use: Significant Analysis Range

"Active" Alloys ASTM Grade	Producer Designation	C*	Mg	Si	Ti	Remarks
2	DH-799	0.08 max	0.01/0.10	0.12/0.20	0.02 max	Si-Mg alloy
3	Inco 225	0.08 max	N.S. (0.03)	0.15/0.25	N.S. (0.02)	Si-Mg alloy
4	DH-599	0.08 max	0.01 max	0.15/0.25	N.S. (0)	Si alloy
	Inco 330	0.08 max	N.S. (0.10)	0.10 max	N.S. (0.02)	Mg-Si alloy
"Normal" Alloy						
11	Inco 220	0.08 max	0.01/0.10	0.01/0.05	N.S. (0.02)	Mg-Si alloy
"Passive" Alloy						
21	DH-499 (1)	0.05 max	0.01 max	0.01 max	0.01 max	Carbon deoxidized

(1) Patented; * Maximum carbon in finished cathodes; N.S. = not specified; ( ) = usual content.
Inco—International Nickel Company, New York, N. Y. D-H—Driver-Harris Company, Harrison, N. J.

Table II. Commercial Cathode Alloys: Significant Analysis Ranges

"Active" Alloys ASTM Grade	Producer Designation	C*	Mg	Si	Ti	Remarks
1	Inco 224	0.08 max	0.01/0.10	0.12/0.20	0.02 max	Si-Mg alloy
2	DH-799	0.08 max	0.01/0.10	0.12/0.20	0.02 max	Si-Mg alloy
3	Inco 225	0.08 max	N.S. (0.03)	0.15/0.25	N.S. (0.02)	Si-Mg alloy
4	DH-599	0.08 max	0.01 max	0.15/0.25	N.S. (0)	Si alloy
5	DH-699	0.08 max	0.05/0.15	0.05/0.15	N.S. (0)	Mg-Si alloy
6	DH-399	0.08 max	0.01 max	0.15/0.25	N.S. (0)	Si alloy
	Inco 330	0.08 max	N.S. (0.10)	0.10 max	N.S. (0.02)	Mg-Si alloy
"Normal" Alloy						
11	Inco 220	0.08 max	0.01/0.10	0.01/0.05	N.S. (0.02)	Mg-Si alloy
"Passive" Alloys						
21	DH-499 (1)	0.05 max	0.01 max	0.01 max	0.01 max	Carbon deoxidized
22	DH-999	0.05 max	0.01 max	0.01 max	0.01 max	Special deoxidized

(1) Patented; * Maximum carbon in finished cathodes; N.S. = not specified; ( ) = usual content.
Inco—International Nickel Company, New York, N. Y. D-H—Driver-Harris Company, Harrison, N. J.

pressure and thus promotes a high sublimation rate of the metallic sleeve often resulting in electrical leakage and shifting characteristics when the magnesium in the cathode alloy exceeds about 0.07 per cent. Magnesium does not produce a high impedance interface between cathode sleeve and coating, and therefore is satisfactory as an activator for pulsed cathodes.

2. *Silicon* is next in commercial importance. Activation is not quite so rapid as with magnesium, but d-c emission life is long and the use of silicon has become popular therefore for a number of types of cathode alloys. Silicon may be present in quantities from 0.01 to 0.25 per cent. Unfortunately silicon seems to promote the formation of an interfacial layer between cathode alloy and coating which has been identified as barium orthosilicate and which is characterized by high electrical impedance which, in turn, results in poor performance of tubes used for pulsed or cut-off purposes. Silicon displays a lower vapor pressure than magnesium and thus does not cause deposits on insulators which result in electrical leakage.

3. *Titanium* is used very sparingly and primarily for its metallurgical effects rather than for its reducing action on the coating, but there are some who have advocated a more careful examination of the usefulness of this element. It is present as a scavenger in many of the cathode alloys, but rarely in the free or uncombined state so that its effect is probably minor in quantities now used. High titanium cathode alloys have been produced in the past, resulting in the formation of a black interfacial layer which effectively reduced the operating temperatu of the cathode. There seems to disagreement as to the electri characteristics of this interface, a it is doubtful that titanium-nick have been used since the advent pulse problems. Such alloys serve more attention and they pro ably will be reviewed again in t near future.

4. *Carbon* apparently may act a reducing agent on the coatin particularly in the absence of a other highly reducing elements, b its role in cathode activation a life has been difficult to establi Due to its high diffusion rate a the formation of gaseous compoun any effect by carbon is probab very short-lived, but may be of i portance in activation of the catho

The foregoing elements have be traditional reducing agents for bo activation and constant regene tion of barium and strontium duri life. The commercial and genera used cathode alloys, classified bo on the basis of their activity and cording to the particular reduci agent or agents which largely determine their performan characteristics, are shown in Tables I and II. Table shows those in common use, while Table II shows t entire list including many which are rarely used today.

The first action of Section *A* on Cathode Alloys American Society for Testing Materials Committee Sub *VIII*, organized in 1945, was to divide the all according to activity into those which were passive, norm and active. This terminology is not exactly definit when related to performance characteristics, but di classify the alloys in a general way with respect to rapid of activation and level of d-c emission during life. T rate of activation is of commercial importance to tu manufacturers, but of little importance to the tube user

The passive metals show extremely slow activati relatively low levels of emission, and extremely long l The normal alloy shows relatively rapid activation, hig levels of emission, and sometimes shorter life. The act alloys are rapid in activation, give slightly higher emission and related tube characteristics, and when u under proper conditions give fairly long life. TH general characteristics are shown in Figure 3. Howe it is our belief that all but the passive alloys are proba outmoded by today's requirements which entail be control of sublimation characteristics, complete freed from interface impedance, longer life, and better streng

Newer alloys which have been introduced recently ones containing aluminum as the activating agent in series, tungsten as both a reducing element and a streng ening element in another series, and cobalt in still anot

Now the use of these three elements is by no means new, since they are long familiar as ingredients in filamentary alloys. However, it was necessary to alter drastically the filamentary alloys, and in general to reduce greatly the content of these elements, before the alloys would behave properly for indirectly heated cathodes. The new compositions are, therefore, quite distinct from the filamentary alloys.

The advantages of aluminum are evident from the characteristics of the element itself—activation is relatively rapid, d-c emission is high and long-lived, and sublimation has proved to be very low. The interfacial compounds (if present) are of low electrical impedance. In fact it may be said here that in our experience only silicon has shown any effect in the creation of an interfacial layer of high impedance. Of course most of the reducing agents cause the formation of a visible interface layer, but these films do not necessarily show electrical impedance. There are indications that the absence of all reducing elements is necessary to the best pulsed performance, that is, passive cathode base metal is indicated.

In addition to doubling the hot strength of a cathode sleeve, the addition of approximately 4-per-cent tungsten seems to enhance the reducing potential of the cathode alloy. Tungsten-nickel alloys have shown reasonably rapid activation, long life under d-c emission conditions, relatively high emission, and complete freedom from interface impedance where the silicon content was sufficiently low. However, tungsten is a strategic element, scarce and high in price, so that tungsten-nickel alloys must be considered as premium ones for special purposes only.

Problems of reliability and shock and vibration resistance are specters which haunt tube engineers these days. Reliability is a problem not only of mechanical perfection of assembly, but also one of long life with freedom from shifts in tube characteristics. It is hoped that the aluminum alloy for indirectly heated cathodes will be a definite contribution to cathode life and stability of characteristics. On the other hand, ruggedization requires stronger cathode alloys which are, at the same time, suitable with respect to all of the afore-described cathode characteristics: not a small order by any means.

Much improvement in shock resistance of cathodes can be effected with existing alloys by the application of simple and well-known laws governing the strength of shapes and materials. In considering this problem it must be understood that the heavier the cathode, the less its resistance to deformation under shock loading. From the same laws it is almost elementary that the larger the diameter and the shorter the length between supports, the stronger is the cathode cylinder. And yet, these simple facts apparently are ignored or forgotten often in tube design work. In connection with this problem, cathode strength curves have been developed which should enable a tube designer to predict with considerable accuracy the resistance of an indirectly heated cathode to shock loading. Figure 4 shows these curves for cathodes operating at a temperature of 775 degrees centigrade. The Bureau of Ships, Department of the Navy, has permitted publication of this small portion of our recent contract development work in the hope that it will be an aid in the design of more rugged and reliable tubes.

In conclusion, it is desirable to emphasize a number of points which derive from the foregoing discussion. The complex oxide cathode structure is temperature dependent, not only as to electron emission but also as to chemical, metallurgical, and physical reactions. It is not an inexhaustible well of electrons; it must not be driven beyond its electron-producing capacity simply by raising the temperature or raising the anode voltage or using a positive grid bias. It cannot be expected to stand up if bombarded by positive ions which act like cannon balls in destroying the emissivity of the coating. Many of the apparent weaknesses of the oxide cathode stem from its misuse and a lack of understanding and appreciation of its characteristics.

Circuit engineers must know a great deal about the internal workings and theories of electron tubes and electron emission, as well as all about the circuits in which they are applying these tubes. When special applications of tubes are involved, it is always necessary for the circuit

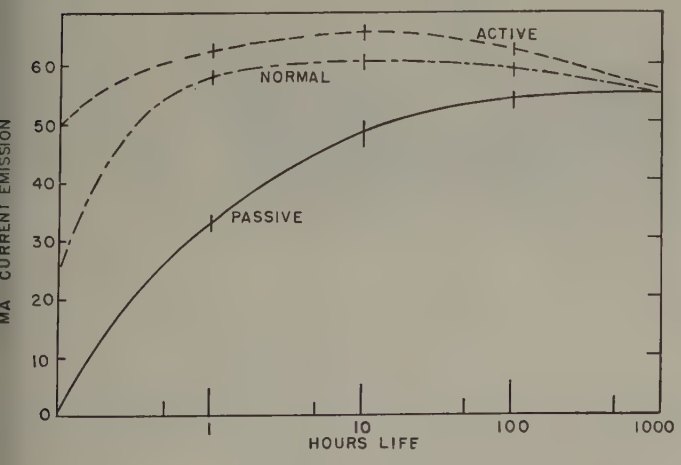


Figure 3. Rate of activation and emission levels typical of active, normal, and passive cathode base materials as tested in the standard American Society for Testing Materials' diode

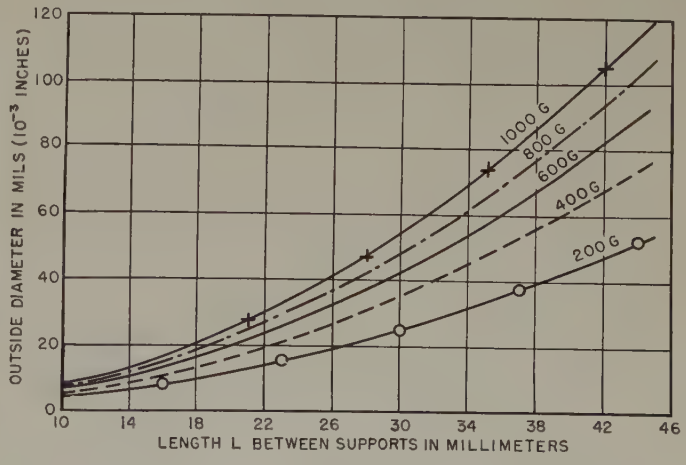


Figure 4. Relation of outside diameter and length between supports for round nickel tubing 0.002-inch wall thickness at several acceleration values and 775 degrees centigrade (based on 0.001-inch deflection at mid-point between supports)

engineer to consult with the applications engineers of the tube manufacturers or with specialists in this field within his own organization. Relatively small differences in applied voltages and signals may be vital; they may change the tube life from 10,000 hours to a matter of hundreds of hours in a most unexpected fashion. To achieve reliability, tubes should be underrated as much as is economically possible. Tubes must be processed for the application for which they are intended.

It also must be recognized that the complexity of materials and processes which are incorporated in the vacuum tube make it difficult both to substitute new alloys in old designs and really to evaluate the effects of these new materials. It also is well known that slight changes in tube characteristics, from whatever cause, greatly complicate the production of replacement tubes. Nevertheless, particularly in the design of new tubes, the electron tube industry now has an opportunity to achieve the reliability and ruggedness required by new and severe applications and specifications through an improved understanding of the indirectly heated oxide cathode and the predictable effects of the nickel alloy used as the base metal.

REFERENCES

1. The Influence of Impurities in the Core Metal on Thermionic Emission From Oxide-Coated Nickel, **M. Benjamin.** *Philosophical Magazine* (London, England) volume 20, number 131, July 1935, pages 1–24.

2. Investigation of Short-Time Thermionic Emission From Oxide-Coated Cathode **L. Sproull.** *Physical Review* (New York, N. Y.), volume 67, 1945, pages 166–78.

3. Leaky Condenser Oxide Cathode Interface, **A. Eisenstein.** *Journal of Appli Physics* (New York, N. Y.), volume 22, number 2, February 1951, pages 138–48.

4. The Oxide-Coated Cathode (book, volume 1), **G. Herrmann, S. Wagener.** Chap man and Hall, London, England, 1951.

5. Conduction Mechanism in Oxide-Coated Cathodes, **R. Loosjes, H. J. Vink** *Phillips Research Reports*, (Eindhoven, Holland), volume 4, number 6, 1949.

6. Conduction Processes in the Oxide-Coated Cathode, **R. Loosjes, H.J. Vink** *Phillips Technical Review* (Eindhoven, Holland), volume 11, March 1950.

7. Contribution to the Study of Oxide Cathodes, **F. Violet, J. Reithmuller.** *An nales de Radioélectricité* T.S.F. (Paris, France), July 1949, (In French. Trans lation available from Superior Tube Company, Norristown, Pa.)

8. Electrical Conductivity of Oxide Cathode Coatings, **D. A. Wright.** *Physical Revie* (New York, N. Y.), volume 78, May 1, 1950, page 355; *British Journal of Applied Physi* (London, England), volume 1, June 1950.

9. New Cathode Design Improves Tube Reliability, **D. R. Hill.** *Electronics*, (New York, N.Y.), volume 24, number 8, August 1951, pages 104–06.

10. Nickel Alloys for Oxide-Coated Cathodes, **A. M. Bounds, T. H. Briggs.** *Pro ceedings*, Institute of Radio Engineers (New York, N. Y.), volume 39, number 7, Jul 1951, pages 788–99.

11. Application of Thermodynamics to Chemical Problems Involved in the Oxid Cathode, **A. H. White.** *Journal of Applied Physics* (New York, N. Y.), volume 20 September 1949, page 856.

12. The Life of Oxide Cathodes in Modern Receiving Valves, **G. H. Metson, S Wagener, M. F. Holmes, M. R. Child.** *Proceedings*, Institution of Electrical Engineer (London, England), volume 39, part 3, number 58, March 1952, pages 69–87.

13. Correlation of D-C and Microsecond Pulsed Emission From Oxide-Coate Cathodes, **F. A. Horak.** *Journal of Applied Physics* (New York, N. Y.), volume 23 number 3, March, 1952, pages 346–50.

14. Activation of High Vacuum Oxide-Cathode Valves, **G. H. Metson.** *Vacuu* (W. Edwards and Company, Ltd., London, England), volume 1, number 4, Octobe 1951, pages 283–93.

Permanent Cartridge Demineralizer Provides High-Purity Water

Employing the monocolumn demineralizing method (a mixed bed of cation and anion resins in a single column) which is effective in the decontamination of water containing mixed fission products, the Penfield Permanent Cartridge Demineralizer is designed to provide mineral-free water for commercial users of reasonable quantities of high-purity water and is also useful as a stand-by or shelf unit for emergency use in hospitals, schools, and defense centers.

The Demineralizer features a permanent cartridge, an electric purity indicator, and a flow meter, a sight indicator for adjusting intake flow to the optimum rate for most efficient ion exchange action.

Capable of supplying up to 10 gallons per hour of high-purity water, the unit weighs only a few pounds and attaches to any wall near a tap or can be mounted on the Penfield Laboratory Stand (see illustration). All that is necessary then to secure high-purity, demineralized water at will, is to connect the intake hose to the tap, insert the outlet hose in a receptacle, and turn on the faucet.

Requiring no heat, steam, or other power for its operation, as water pressure does the entire job, the Demineralizer performs its ion exchange function without boil-outs or odor and features a permanent cartridge design which does away with the need to purchase new cartridge and screens when the resins need replacing. One resin charge furnishes 200 to 230 gallons of mineral-free water. The electric purity meter built into the unit plugs into any a-c outlet to provide continuous conductivity information relative to the purity

of the treated water, warning when the resin charge in the permanent cartridge requires simple dumping and replacing.

However, the Demineralizer performs its functions regardless of whether or not the purity meter is plugged in and operating. During an emergency and the possible absence of electric power, all that is necessary is to turn the faucet to optimum intake flow rate, as indicated on the flow meter, and keep track of gallonage output so that the resin charge may be replaced at proper intervals.

Transient Analysis of the Metadyne Generator

M. RIAZ
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SINCE WORLD WAR II, the increased use of direct current for ship propulsion, aircraft systems, and feedback control systems has refocused attention on the potentialities offered by d-c machines in many novel forms. However, the full possibilities of these machines can be realized only after consideration of a more general class of machines known as metadynes. This article presents an analysis of the transient performance of one fundamental type: the so-called S-generator or cross-connected metadyne.

The metadyne constitutes a generalization of the conventional d-c machine in which special use is made of armature reaction to control the machine characteristics. This utilization of armature reaction is obtained through placing extra sets of brushes between those of the conventional d-c machine. An elementary S-generator metadyne is shown schematically in Figure 1 with several kinds of series windings placed on the stator to control its steady-state and transient characteristics.

The transient equations describing the performance of this metadyne are obtained by adapting some fundamental elements of matrix analysis (as developed by Kron) to the case of commutator machines of the metadyne type. The method, so to speak, suggests itself logically not only because of its complete automaticity and great power but also because it particularly fits the case of a generalized concept such as the metadyne, which can be viewed as a physical representation of Kron's "primitive" machine. Commutation, the effects of saturation, and the non-sinusoidal distribution of flux densities are included as characteristic of the structure of a commutator machine.

The solutions of the equations reveal unique characteristics: notably, the constant-current behavior inherent to the metadyne, which is demonstrated under transient conditions by a strong field-forcing action causing the quick response of the machine. A typical transient response is illustrated in the oscillograms of Figure 2 (which correspond to the metadyne arrangement of Figure 1 without the series windings) and is contrasted to the case of a conventional separately excited d-c generator (obtained by connecting across the quadrature brushes the same inductive load used in the metadyne configuration and by opening the direct-axis circuit). The oscillatory nature of the metadyne system is clearly demonstrated and so is its speed of response. This quick action is realized at the expense of a loss in amplification and stability of the system, and this reduced stability may lead, in certain instances, to self-excitation of the metadyne. Such characteristics, which differ greatly from those of ordinary d-c machines, point out the vast potentialities offered by metadynes for industrial applications.

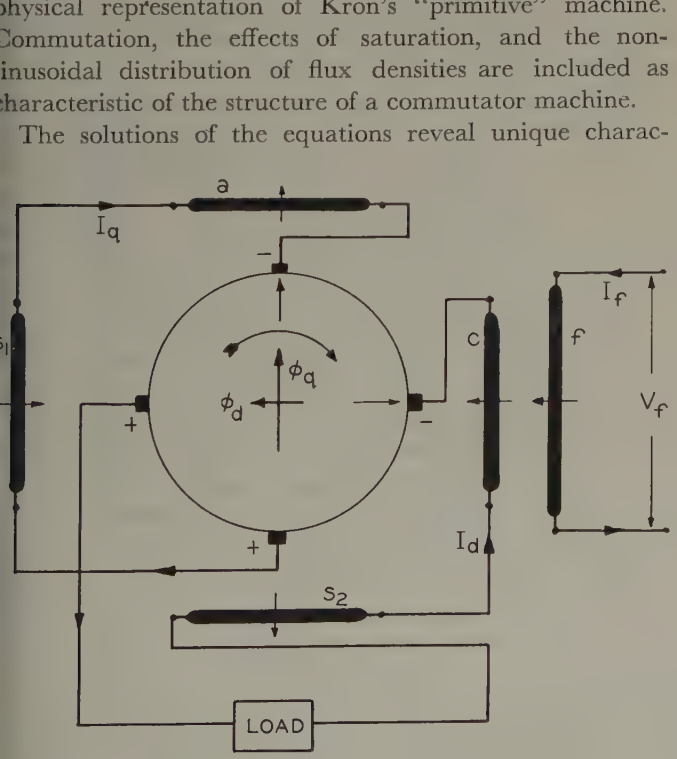

Figure 1. Metadyne generator

f = control field winding
c = compensating winding
s = stabilizing winding
a = amplifying winding

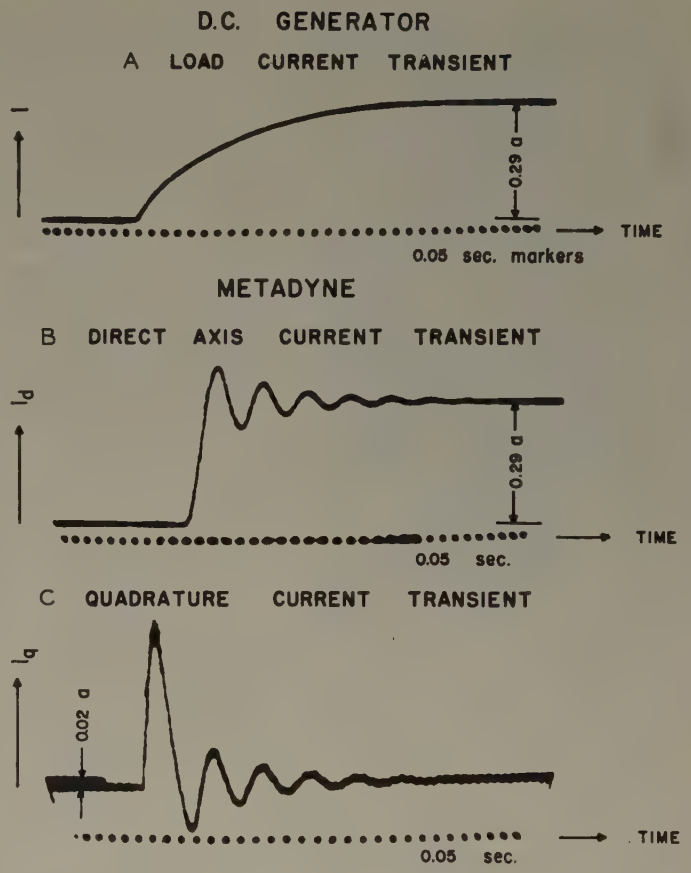

Figure 2. Transient response

Digest of paper 53-84, "Transient Analysis of the Metadyne Generator," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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Using Relays for Unbalanced Faults on Generators

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THE REVISION OF THE STANDARD describing "Short-Circuit Requirements" for synchronous rotating machines is of considerable interest to the relay engineer. The quantitative statement of current-time capability of the generator makes available a basis for co-ordination of system and machine relaying on unbalanced faults. The permissible time duration of unbalanced faults is expressed as a variable based on I_2^2t being constant, where I_2 is the negative-sequence component of generator armature current and t is the time in seconds.

It is desirable to consider using a relay specifically designed to prevent rotor failure due to excessive negative-sequence current, since adequate relays have been made available and the capabilities of generators have been more closely defined. The generator negative-sequence current relays match the generator thermal-capability curve and permit operation to a point just below that where the possibility of machine damage arises, giving a maximum margin for co-ordination with other relays with a minimum of application effort.

In general, a generator falls into one of four cases, depending on whether it has a voltage regulator and how it is connected to the system: A. Generator without voltage regulator connected directly to the system; B. Generator without a voltage regulator connected to the system through a transformer; C. Generator with a voltage regulator connected directly to the system; D. Generator with a voltage regulator connected to the system through a transformer.

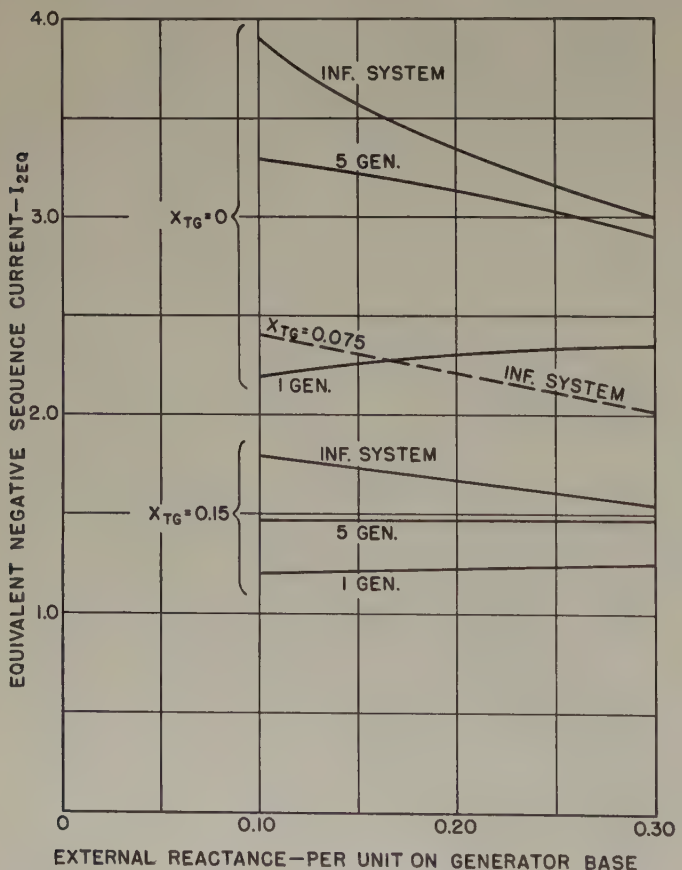

Figure 1. Equivalent negative-sequence current in generator for line-to-line faults as a function of external reactance, generator transformer reactance, and system size

In applying a generator negative-sequence current relay the relay engineer is concerned about the closing time of the relay for different faults, in order to check the co-ordination with system relaying. The minimum closing time is caused by a line-to-line fault, which gives the largest magnitude of negative-sequence current for a given fault location.

Figure 1 shows the results of studies of various systems under cases A and B. The equivalent negative-sequence current is that constant value of current such that I_{2eq}^2t is equal to the integrated product of i_2^2t, where i_2 is variable as a function of time. For a turbine generator the standard limits I_2^2t to 30, and an equivalent negative-sequence current of 2.74 per unit gives a permissible time of 4 seconds. Figure 1 shows that a generator connected to a system of any size through a transformer (case B) gives a current less than 2.74 per unit, with ample time for relay co-ordination. Generators using voltage regulators give higher values of negative-sequence current because of the forcing effect of the regulator. The sustained current is increased for prolonged faults, and for practical purposes the equivalent negative-sequence current can be set equal to the sustained magnitude.

Two aspects of generator negative-sequence current relaying warrant almost equal weight: the first is the assurance that the relay provide adequate protection for the generator; and the second is that the relay must never operate falsely under normal conditions or when normal system relaying operates correctly. It is also desirable that the system data upon which the relay application depends be easily calculable in a sufficiently accurate form to assure correct relay operation for all cases. A comparison of various relay schemes indicates that the negative-sequence relay fulfills these requirements with the greatest reliability.

The time-current characteristic of the negative-sequence relay is matched closely to the capability of the generator to withstand the damaging current. In the majority of applications it is not necessary to make any calculation of generator negative-sequence current to determine the relay clearing time because the time will be sufficiently long to eliminate any question of co-ordination with system relaying.

Digest of paper 53-41, "Application of Relays for Unbalanced Faults on Generators," recommended by the AIEE Committee on Relays and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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High-Power Industrial Vacuum Tubes

R. B. AYER

THORIATED-TUNGSTEN WIRE, developed nearly 40 years ago by the lamp industry, has found extensive application as an electron emitter in vacuum tubes over the last 30 years, first in receiving and small-power types and more recently in high-power industrial types such as the *RCA-5770*, *RCA-5771*, and *RCA-5831*. High-power types are considered as those having unmodulated class *C* plate voltage ratings of greater than 5,000 volts.

Emission efficiencies 10 to 15 times that of pure tungsten are obtained at operating temperatures 500 to 600 degrees Kelvin lower than that of pure tungsten. Processing of thoriated-tungsten filaments involves high-temperature flashing, first in an appropriate gas atmosphere to carburize the wire and then in a vacuum to produce metallic thorium and diffuse it to the surface. In carburization, a thin shell of tungsten carbide is formed to aid in maintaining filament activation and in achieving longer life. Data on the rate of loss of this carbide as a function of operating temperature have made it possible to predict the emission life of thoriated-tungsten filaments.

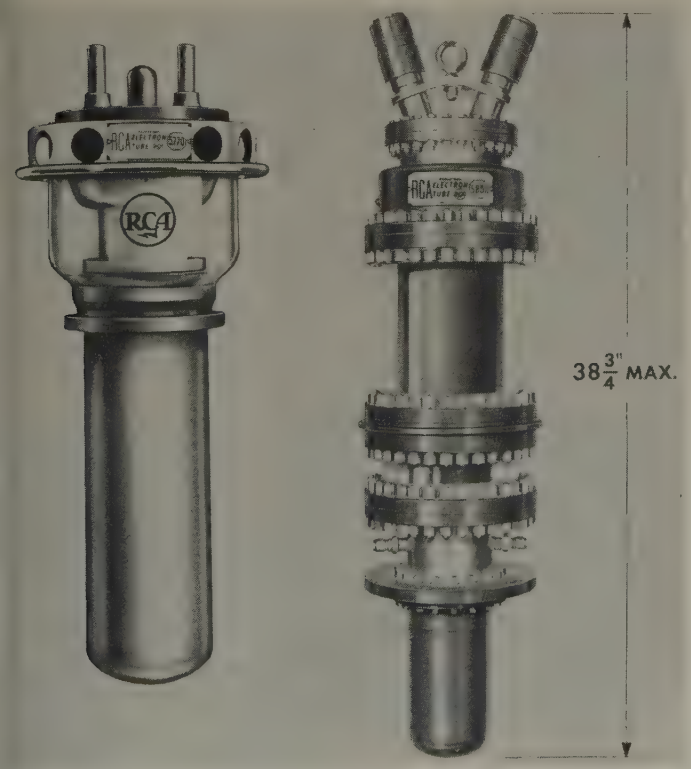

Figure 1 (left). RCA-5770 delivers a power output of over 100 kw at frequencies as high as 20 megacycles when used in unmodulated class C service with a plate current of 8.5 amperes at 17 kv and a driving power of approximately 2,300 watts. (Right) RCA-5831 water-cooled superpower beam triode delivers a power output of approximately 500 kw at frequencies up through the standard broadcast band when used in unmodulated class C service with a plate current of 39 amperes at 16 kv and a driving power of approximately 900 watts

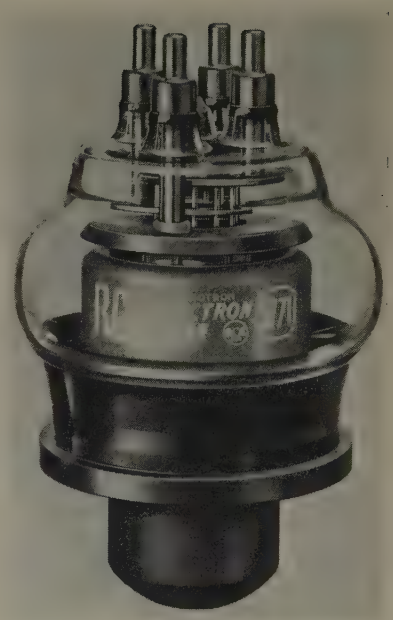

Figure 2. RCA-5771 delivers a power output of over 50 kw at frequencies as high as 25 megacycles when used in unmodulated class C service with a plate current of 4.5 amperes at 15 kv and a driving power of about 1,160 watts

Early unsuccessful attempts to use thoriated-tungsten filaments in high-power tubes led to the general belief that such filaments could not be used in tubes having plate voltage ratings above 5,000 volts. This belief is reflected in the literature and in books published as recently as 1951. However, tests started in 1940 have proved that this long-standing belief is erroneous. In fact, there now appears to be no practical limitation on the power or operating plate-voltage level. New materials, simplified mechanical structures, improved processing facilities, and greater cleanliness have contributed to the successful use of thoriated-tungsten filaments in high-power industrial tubes.

Examples of such tubes are the *RCA-5770*, *RCA-5771*, and *RCA-5831*. These tubes have output capabilities ranging from 50 to 500 kw, plate voltage ratings between 15 and 17 kv, and maximum frequency ratings at full input from 1,600 kc up to 25 megacycles. Operation in induction-heating and in dielectric-heating applications has been exceptional with no evidence of deterioration even after approximately 3 years of continuous service.

A saving of 60 to 70 per cent in filament heating power over that required for equivalent pure-tungsten filament types results in a substantial saving in operating costs. As an example, the *RCA-5770* requires 5.0 kw less filament power than its pure-tungsten equivalent. Other advantages resulting from the lower operating temperature make these tubes very attractive for industrial use where long life and reliable performance are of paramount importance.

Digest of paper 53-173, "High-Power Industrial Vacuum Tubes Having Thoriated-Tungsten Filaments," recommended by the AIEE Committee on Electronics and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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Summer Meeting in Atlantic City to Feature Week of Technical and Social Activities

A full week of technical sessions and social activities awaits those who plan to attend this year's Summer General Meeting, June 15–19. With one of the country's foremost seaside resorts, Atlantic City, N. J., as the site, members of the AIEE Philadelphia Section will act as hosts for this meeting which also commemorates the Section's 50th anniversary. Headquarters will be at the Chalfonte-Haddon Hall Hotels on the boardwalk.

The week's program will open with the annual meeting on Monday, at which the election of officers will be announced and President D. A. Quarles will deliver the main address. A feature of the session will be the presentation of the Lamme Medal to I. F. Kinnard "for his outstanding contributions in design and developments in the field of instrumentation and measurements."

Professor Edwin H. Armstrong, Columbia University, was elected an Honorary Member by the Board of Directors, and he will address the General Meeting.

INSPECTION TRIPS

Station WFPG-TV, Atlantic City, N. J. (Tuesday and Wednesday, June 16 and 17). Trips will be made through this new ultra-high-frequency–television station on the afternoons of both days.

Bell Telephone Company of Pennsylvania, Philadelphia, Pa. (Thursday and Friday, June 18 and 19). The Automatic Message Accounting center recently established in Philadelphia has been designed to mechanize the operations which summarize and compute data on telephone calls for the purpose of billing the customer. As calls are dialed by the customers all of the items of information relating to a call are recorded on paper tape by means of perforations. At the accounting center, these data are collected automatically and the charges for the calls computed. This is one phase of the development which soon will enable the customer's bill to be printed automatically.

Westinghouse Electric Corporation, Lester, Pa. (Thursday and Friday, June 18 and 19). Members making this trip will see, in the process of manufacture, assembly, and test, such apparatus as industrial and central station turbines for driving generators, mechanical-drive turbines, surface condensers, heat exchangers, circulating and condensate pumps, and evaporators.

Proof of citizenship will be required by those planning to make this trip.

General Electric Company Switchgear Development Laboratory, Philadelphia, Pa. (Thursday and Friday, June 18 and 19). This is the largest and most modern laboratory of its type in the world. In its control building are centralized control and instrumentation equipments which indicate or record every electrical phenomenon which proves or disproves the value of circuit-breaker performance under short-circuit conditions. From these devices 400 miles of wire reach out to every device within the entire laboratory. In a matter of seconds a film record of electrical phenomena that took place in a switchgear interrupting device during a regular or short-circuit test is on the reading tables in the control room for observation.

In the generator room are two huge generators, the largest ever built for short-circuit testing. They are designed to absorb the tremendous shocks produced during short-circuit tests. The stator of each generator is supported on huge spring-steel legs. Under the most severe shor circuit, developing 8,000,000 foot-pound of torque, frame rotation is about 1/2 inc each way at the point of attachment of th springs. These "legs" allow the stator t rotate through this small angle and stil remain in perfect alignment with the roto

Future AIEE Meetings

Summer General Meeting
Chalfonte-Haddon Hall Hotels,
Atlantic City, N. J.
June 15–19, 1953
(*Final date for submitting papers—closed*)

Pacific General Meeting
Hotel Vancouver, Vancouver, British Co lumbia, Canada
September 1–4, 1953
(*Final date for submitting papers—June 30*)

Middle Eastern District Meeting
Daniel Boone Hotel, Charleston, W. Va.
September 29–October 1, 1953
(*Final date for submitting papers—June 30*)

Aircraft Electric Equipment Conference
Benjamin Franklin Hotel, Seattle, Wash.
September 30–October 2, 1953

Conference on Fractional-Horsepower Motors
Hotel Van Orman, Fort Wayne, Ind.
October 6–8, 1953

Conference on Machine Tools
Cleveland Hotel, Cleveland, Ohio
October 14–16, 1953

Fall General Meeting
Muehlebach Hotel, Kansas City, Mo
November 2–6, 1953
(*Final date for submitting papers—July 6*)

(Left) The famed Atlantic City boardwalk with the Chalfonte-Haddon Hall Hotels in the background and (right) an aeria view of the beach

haft. They take the brunt of the short ircuit instead of the windings under short-ircuit conditions.

In the high-voltage yard are huge power ransformers capable of stepping up the oltage to 400,000 volts for testing circuit reakers and other equipment. In this ame area are capacitor banks for simulating ctual conditions such as charging currents n high-voltage transmission lines up to 200 niles in length at 230,000 volts.

Limited accommodations are available. Reservations must be made at Atlantic City at time of registration.

In addition to these inspection trips, as a pecial feature of the meeting, motion pic-ures covering various industrial and educa-ional subjects will be shown each afternoon, Monday through Friday, in the Viking Room of Haddon Hall.

SOCIAL ACTIVITIES

A number of social activities have been planned for the evenings during the meeting by a committee under the chairmanship of . B. Harris.

An informal bingo and card party will be eld on Monday evening, for which there vill be no charge. Refreshments and prizes vill be provided.

On Tuesday, cocktails will precede a linner and show featuring Vivian Della Chiesa, popular radio soprano; Conrad Thibault, well-known baritone; the Har-nonicaires, harmonica band; and the lance team, Laurette and Clymas. The ccompaniment will be furnished by Howard anin's orchestra. Price per ticket is 8.50 at the ticket desk.

A cabaret dance is scheduled for Wednes-lay evening at Haddon Hall at which ocktails and other beverages will be served. Howard Lanin's orchestra will be featured, n addition to a female vocalist and a square lance group. Tickets will be available at he ticket desk at $2.50 each.

For Thursday, a moonlight boat trip is planned along the coast of Atlantic City. Bus transportation will be provided to and rom the hotel to the dock. The price per icket is $2.00 at the ticket desk.

A number of activities of special interest o the ladies also have been arranged. In harge of this program is the Ladies' Com-nittee under the chairmanship of Mrs. H. R. Paxson.

On Sunday afternoon, an informal tea vill be held for AIEE members and their amilies, and on Monday afternoon the adies are invited to take a complimentary ight-seeing trip around the island and own to Ocean City.

A luncheon and millinery show are lanned for Tuesday at the Marlborough-Blenheim Hotel at which hats will be nodeled by the visitors and one of the hats warded as a door prize. Luncheon tickets vill be $3.00 each.

A marine sight-seeing trip has been cheduled for Wednesday morning. Both us transportation to the dock and the oat trip are free-of-charge.

On Thursday morning an inspection tour vill be made through the Haddon Hall itchens and laundry.

SPORTS

The sports program under the leadership f A. D. Brown has been rounded out to nclude arrangements for the duffer and amateur as well as the seasoned golfer and angler.

Facilities for golf will be available at the Atlantic City Country Club at Northfield, N. J. The green fee is $4.00 on weekdays. Ladies and men both may participate and the facilities of the pitch and putt course and putting greens may be used also. Golf scores and scores for the pitch and putt course and putting contests should be turned in to the AIEE Sports Committee representative. There will be prizes for both ladies and men.

For those interested in fishing, half-day trips leave from Starn's Boat Dock, Atlantic City Inlet, at an approximate cost of $3.25 per person, and all-day fishing trips are available also. Deep-sea sport fishing can be arranged at a day's notice. These boats accommodate six persons and the rate is approximately $65 for weekdays. Tackle may be rented by the hour or day. There will be prizes for the largest and smallest fish; men, women, and children may compete.

Small power boats accommodating five people can be had for $12 rental for the day or at special hourly rates.

RESERVATIONS AND REGISTRATION

The Summer General Meeting, while it assuredly has its serious technical aspects, also can afford the opportunity for a pleasant vacation; hence the selection of Atlantic City as this year's meeting site. This thought was carried out also in the assignment of the Chalfonte-Haddon Hall Hotels as meeting headquarters.

A Hotel Accommodations Desk, devoted exclusively to the best utilization of the hotels' numerous facilities, will be established in the registration area.

Transportation to Atlantic City can be arranged very easily from both Philadelphia, Pa., and New York, N. Y. It can be reached by bus from Philadelphia and New York City; by train from 30th Street Station, Philadelphia, via Pennsylvania-Reading Seashore Lines; by automobile from New York City via the New Jersey Turnpike, thence on Route 43, also via Route 9; by automobile from Philadelphia via Route 43; by airplane from New York's Idlewilde Airport and Philadelphia's International Airport.

The Registration Desk will be open Sunday afternoon, June 14, from 2:30 to 4:30 and daily thereafter from 8:30 a.m. to 4:30 p.m. for the duration of the meeting. A registration fee of $3.00 will be charged all members and of $5.00 for nonmembers. Enrolled students and guests will be registered without payment of registration fees.

Directors, officers, and delegates will be registered in advance and may receive credentials from a desk provided for this purpose in the registration area.

COMMITTEE

The members of the 1953 Summer General Meeting Committee are: L. R. Gaty, General Chairman; B. L. England, W. F. Henn, Vice-Chairmen; R. W. Wilbraham, Treasurer; A. C. Muir, Institute Director; R. M. Pfalzgraff, D. B. Smith, Members-at-Large; J. C. Strasbourger, Vice-President, District 2; W. F. Denkhaus, Arrangements; J. B. Harris, Jr., Entertainment; R. W. Wilbraham, Finance; H. F. Davis, Hotels; Mrs. H. R. Paxson, Ladies; M. L. Stoughton, Publicity; T. E. Stieber, Registration; A. D. Brown, Sports; Arthur Pringle, II, Inspection Trips and Science Theater; S. R. Warren, Students; W. R. Clark, Technical Program; W. G. Salmonson, Transportation.

Lamme Medal Nominations for 1953 Due December 1

Special attention is directed to the fact that the names of Institute members who are considered eligible for the AIEE Lamme Medal, to be awarded early in 1954, may be submitted by any member in accordance with section 1 of article VI of the bylaws of the Lamme Medal Committee, as follows:

"The committee shall cause to be published in one or more issues of *Electrical Engineering*, or of its successors, each year, preferably including the June issue, a statement regarding the Lamme Medal and an invitation for any member to present to the Secretary of the Institute by December 1, the name of a member as a nominee for the medal, accompanied by a statement of his 'meritorious achievement' and the names of at least three engineers of standing who are familiar with the achievement."

Each nomination should give concisely the specific grounds upon which the award is proposed, and also a complete detailed statement of the achievements of the nominee, to enable the committee to determine its significance as compared with the achievements of other nominees. If the work of the nominee has been of a somewhat general character in co-operation with others, specific information should be given regarding his individual contributions. Names of endorsers should be given as specified in the foregoing quotation.

Article V, section 2, specifies that: "The committee in making the award shall carefully observe the limitation imposed by Mr. Lamme, that the recipient must have 'shown meritorious achievement in the development of electric apparatus and machinery.' This shall be taken to mean that the meritorious achievement must be of such character that it has resulted or will result in the production of substantially improved electric apparatus or machinery. Any work which meets this requirement is admissible whether it be (*a*) in development of the theory involved; (*b*) in development of the characteristics of the materials employed; (*c*) in development of over-all design; or (*d*) in development in other ways which results in substantial improvement in electric apparatus or machinery. The words 'electric apparatus or machinery' shall be taken to indicate discrete and self-contained devices which may or may not include mechanical moving parts without limitation as to the field of application. They shall not be taken to include transmission or distribution systems as a whole, but rather to include the apparatus and machinery that is used in making up such systems."

Tentative Technical Program

Summer General Meeting, Atlantic City, N. J., June 15-19

Monday June 15

10:00 a.m. Annual Meeting

1. Report of Board of Directors. H. H. Henline, Secretary
2. Report of Treasurer. W. J. Barrett
3. Report of Committee of Tellers on:
   (*a*). Votes for nominees for AIEE offices
   (*b*). Proposed Constitutional amendments
4. (*a*). Introduction of, and presentation of President's badge to, Elgin B. Robertson
   (*b*). Response by Mr. Robertson
5. Introduction of District Branch prize winners
6. Presentation of Lamme Medal to I. F. Kinnard, General Electric Company, West Lynn, Mass.
   (*a*). The Establishment of the Medal. Lester L. Bosch, Chairman, Lamme Medal Committee
   (*b*). The Career of the Medalist. Everett S. Lee, Editor, *General Electric Review*, Schenectady, N. Y.
   (*c*). Presentation of the medal and certificate by President D. A. Quarles
   (*d*). Response by Mr. Kinnard
7. Any other business that may be presented
8. Address by Professor Edwin H. Armstrong, Columbia University
9. Address by President D. A. Quarles

2:00 p.m. Protective Devices

53-272. Change in Resistance of Aircraft Current Limiters and Its Effect on Current Division in Networks. *Henry Oman*, Boeing Airplane Company. Re-presented for discussion

53-183. The Duty on Expulsion-Type Lightning Arresters for Distribution Systems. *Otto Ackermann*, Westinghouse Electric Corporation. Re-presented for discussion

53-273. Use of 10×20 Current Waves for Lightning Arrester Tests. *H. A. Cornelius*, Public Service Company of Northern Illinois. Re-presented for discussion

53-274. Ground Fault Neutralizer Grounding of Unit-Connected Generators. *H. R. Tomlinson*, New England Power Service Company

53-201. Application Guide on Methods of Neutral Grounding of Transmission Systems. *Working Group of the AIEE Subcommittee on Fault Limiting Devices.* Re-presented for discussion

2:00 p.m. Electronic Power Converters

53-288. Water Cooling Systems of Mercury-Arc Rectifiers. *Working Group on Water Cooling Systems of Mercury-Arc Rectifiers*

CP. Low-Temperature Operation of Ignitrons.** *H. E. Zuvers, J. L. Zehner*, General Electric Company

CP. Mechanical Rectifier Circuits and Transformer Connections.** *E. J. Diebold*, I-T-E Circuit Breaker Company

53-242. Voltage Regulation of 12-Phase Double-Way Rectifiers. *R. L. Witzke, J. V. Kresser, J. K. Dillard*, Westinghouse Electric Corporation

53-271. Equivalent Machine Constants for Rectifiers. *I. K. Dortort*, I-T-E Circuit Breaker Company. Re-presented for discussion

2:00 p.m. Substations

53-104. Performance of Electrical Joints Utilizing New Silver Coating on Aluminum Conductors. *T. J. Connor, W. R. Wilson*, General Electric Company. Re-presented for discussion

53-237. Substation 1-Line Diagrams. *Working Group on 1-Line Diagrams of the Committee on Substations*

53-238. Reclosing Fuses, Automatic Oil Circuit Reclosers, and Automatic Reclosing Circuit Breakers in the Distribution Substation. *Working Group on Breakers Versus Reclosing Fuses of the Committee on Substations*

53-239. Grounding Grids for High-Voltage Stations. *E. T. B. Gross*, Illinois Institute of Technology; *B. V. Chitnis*, American Gas and Electric Service Corporation; *L. J. Stratton*, Armour Research Foundation

53-240. Design Charts for Determining Optimum Ground Rod Dimensions. *J. Zaborszky, J. W. Rittenhouse*, University of Missouri

53-241. Lightning Protection in Extra-High-Voltage Stations—Influence of Multiple Circuits. *I. W. Gross*, American Gas and Electric Corporation; *L. B. LeVesconte*, Sargent and Lundy; *J. K. Dillard*, Westinghouse Electric Corporation

—PAMPHLET reproductions of authors' manuscripts of the numbered papers listed in the program may be obtained from AIEE Order Department, 33 West 39th Street, New York 18, N. Y., as noted in the following paragraphs.

—PRICES of papers, irrespective of length, are 30 cents to members (60 cents to nonmembers) whether ordered by mail or purchased at the meeting. Mail orders are advisable, particularly from out-of-town members, as an adequate supply of each paper at the meeting cannot be assured. Only numbered papers are available in pamphlet form.

—COUPON books in nine-dollar denominations are available for those who may wish this convenient form of remittance.

—THE PAPERS regularly approved by the Technical Operations Committee ultimately will be published in the bimonthly publications and Transactions; also, each is scheduled to be published in Electrical Engineering in digest or other form.

2:00 p.m. Facsimile

53-297. A Level Compensator for Telephotograph Systems. *T. A. Jones, W. A. Phelps*, Bell Telephone Laboratories, Inc.

CP. Transmitting X-Ray Photographs by Facsimile.** *K. R. McConnell*, Times Facsimile Corporation

CP. The Facsimile Transmission of News and News Photographs for Television.** *J. V. L. Hogan*, Hogan Laboratories, Inc.; *Dewey Frezzolini*, International News Photos

CP. A Discussion of Synchronizing Systems.** *F. T. Turner*, Western Union Telegraph Company

2:00 p.m. Storage Batteries

Tuesday, June 16

9:00 a.m. Section Delegates Conference

9:00 a.m. Electrical Techniques in Medicine and Biology

CP. Miniature Electrostatic Sources of High Voltage for Radiation Instrumentation.** *S. R. Gilford, S. Saito*, National Bureau of Standards

CP. An Electronic Flowmeter.** *H. P. Kalmus*, National Bureau of Standards

CP. Measurements of Materials With High Dielectric Constant and Conductivity at Ultrahigh Frequencies.** *H. P. Schwan, Kam Li*, University of Pennsylvania

53-206. Heating of Fat-Muscle Layers by Electromagnetic and Ultrasonic Diathermy. *H. P. Schwan, E. L. Carstensen, Kam Li*, University of Pennsylvania

9:00 a.m. Television

CP. An Ultrahigh-Frequency Transmitter Employing a Klystron Power Amplifier.** *W. H. Say Jr.*, Allen B. Du Mont Laboratories

53-299. Technical Characteristics of FTL Type Number 20-B Ultrahigh-Frequency Television Transmitter. *E. M. Bradburd*, Federal Telecommunications Laboratories

CP. Review of Television Abroad.** *E. A. Lapo C. W. Slaybaugh*, RCA International

CP. Engineering Plans for Theater Television** *A. Forman*, Tele-Tech

CP. The Chromatron, A Single or Multigun Tricolor Cathode-Ray Tube.** *R. Dressler*, Chromatic Television

9:00 a.m. Relays

53-195. An Analysis of Polyphase Directional Relay Torques. *C. J. Baldwin, Jr.*, Westinghouse Electric Corporation; *B. N. Gafford*, University of Texas

53-200. A Pilot-Wire Relaying Scheme Utilizing the Product Differential Relay. *R. I. Ward, D. Gilman*, Commonwealth Edison Company

53-210. Field Experience—Electronic Mho Distance Relay. *H. C. Barnes*, American Gas and Electric Service Corporation; *R. H. Macpherson*, General Electric Company

53-211. Phase Comparison Carrier Relaying on 3-Terminal Lines. *H. W. Lensner*, Westinghouse Electric Corporation

9:00 a.m. New Developments in Digital Computers

53-286. Pulse-Response Characteristics of Rectangular-Hysteresis-Loop Ferromagnetic Materials. *Joseph Wylen*, Burroughs Adding Machine Company

CP. A High-Speed Special-Purpose Computer Using a Magnetic Drum Memory.** *R. T. Gord* General Electric Company

CP. Phase System of Magnetic Recording Used for the EDVAC Drum Memory.** *Donald Eas* University of Florida

53-287. A Progressive Code Digital Quantizer. *Floyd Raasch*, Minneapolis-Honeywell Regulator Company

9:00 a.m. Instruments and Measurements

53-281. 40- to 4,000-Microwatt Power Meter. *W. Lange*, Bell Telephone Laboratories, Inc.

53-197. The Use of Steel Sheet for the Construction of Shielded Rooms. *A. M. Intrator*, United States Naval Civil Engineering Research and Evaluation Laboratory

CP. Precise Measurement of Repeater Transmission.** *T. Slonczewski*, Bell Telephone Laboratories Inc.

CP. The Quasi-Peak Voltmeter.** *C. W. Fr* General Electric Company

9:00 a.m. Utility Charges for Service Resistance Welders

CP. Fundamentals of Electric Rate Making.** *R. Lefferson*, Ebasco Services, Inc.

CP. Utility Metering of Resistance Welding Loads.** *M. A. Faucett, C. A. Keener*, University of Illin

CP. Why Special Utility Charges for Resistance Welders?** *R. E. Young*, Public Service Company

CP. A High-Output-Low-Demand Resistance Welding Machine.** *R. S. Phair*, The Budd Company

53-296. Design of Transformers for Resistance Welding Machines. *D. L. Knight*, National Electric Welding Machines Company. Re-presented for discussion

** **CP:** Conference paper; no advance copies are available; not intended for publication in *Transactions*.

1:30 p.m. Section Delegates Conference

2:30 p.m. Management

CP. An Outline of the Principles, Skills, and Tools of Management.** *R. M. Besse*, The Cleveland Electric Illuminating Company

CP. Engineering Economy as a Tool of Management.** *E. D. Ayres*, Ohio State University

1:30 p.m. Binaural Broadcasting

CP. Binaural Transmission by Frequency-Modulation Multiplex.** *M. G. Crosby*, Crosby Laboratories

CP. Stereophonic Recording Equipment.** *R. J. Tinkham*, Ampex Electric Corporation

CP. Better Realism With Binaural Sound Reproduction.** *H. T. Sherman*, Sherman Studios

CP. Engineering and Subjective Aspects of the Binaural Medium.** *E. Cook*, Cook Laboratories

1:30 p.m. Electron Tubes

CP. A New Ultrahigh-Frequency Amplifier Tube.** *Byron Stokes*, Sylvania Electric Products, Inc.

CP. A Monoscope Tube for Computer and Other Appliances.** *John Hartmann*, Allen B. Du Mont Laboratories, Inc.

53-307. Heat Transfer From Electron Tubes at High Altitudes and High Ambient Temperatures. *Mrs. B. O. Buckland*, General Electric Company

1:30 p.m. Instruments and Measurements

53-291. Preliminary Development of a Magnettor Current Standard. *E. P. Felch*, Bell Telephone Laboratories, Inc.; *J. L. Potter*, Rutgers University

53-292. A Commutatorless D-C Tachometer. *A. R. Eckels, W. R. Peck*, University of North Carolina

53-293. An Automatic Transfer Function Measuring and Recording System. *R. J. Ehret, E. F. Hochschild, J. M. Embree, E. C. Grogan*, Minneapolis-Honeywell Regulator Company

CP. A Small Aircraft Instrument Servomotor.** *L. T. Akeley, J. R. Macintyre*, General Electric Company

1:30 p.m. Insulated Conductors

53-228. A Critical Soil Moisture Condition Affecting Buried Transmission Cables. *W. A. Hadley, R. Eisenstadt*, Columbia University

53-230. A Simplified Mathematical Procedure for Determining the Transient Temperature Rise of Cable Systems. *J. H. Neher*, Philadelphia Electric Company

53-214. Tests of Fittings on Insulated Aluminum Cable. *Joel Tompkins, E. K. Lanctot*, Aluminum Company of America. Re-presented for discussion

Wednesday, June 17

9:00 a.m. Land Transportation

53-264. Controlling D-C Arcs. *R. L. Hurtle*, General Electric Company

CP. Service Performance of New Trolley Coach Equipment.** *B. F. Krings*, Westinghouse Electric Corporation

CP. Trolley Coach Versus Motor Coach—Here's 15 Years of Competitive Operating Costs.** *L. W. Birch*, Ohio Brass Company

9:00 a.m. Switchgear

CP. An Analysis of an Analogue Solution Applied to the Heat Conduction Problem in a Cartridge Fuse.** *A. E. Guile*, Queen Mary College, University of London; *E. B. Carne*, Remington Rand, Inc.

53-212. Testing Inhibited Oils in Circuit Breakers. *W. M. Leeds*, Westinghouse Electric Corporation; *R. F. Seubert*, Koppers Company, Inc.

53-231. Features of the Philadelphia Switchgear Development Laboratory. *W. F. Skeats, R. L. Williams*, General Electric Company

9:00 a.m. Insulation of Rotating Machinery

53-301. Motor Insulation Life as Measured by Accelerated Tests and Dielectric Fatigue. *C. J. Herman*, General Electric Company. Re-presented for discussion

53-207. A Method of Evaluating Insulation Systems in Motors. *C. B. Leape, J. McDonald, G. P. Gibson*, Westinghouse Electric Corporation. Re-presented for discussion

CP. The Evaluation of Class H Motor Insulation Systems.** *J. F. Dexter, E. Earleywine*, Dow-Corning Corporation

CP. Aging Effects on Insulation Resistance at High Temperatures.** *J. L. Fuller, P. H. Kahelin*, Reliance Electric and Engineering Company

CP. Effect of Voltage and Vibration on Insulation.** *A. T. McClinton*, Naval Research Laboratory

CP. Statistical Analysis in Functional Evaluation of Insulation.** *John Cybulski*, Naval Research Laboratory

9:00 a.m. Magnetic Recording

CP. Present Status of Magnetic Recording.** *R. E. Zenner*, Armour Research Foundation

53-300. Synchronized Magnetic-Tape Recording. *R. H. Ranger*, Rangertone, Inc.

CP. Structure and Performance of Magnetic Transducer Heads.** *L. L. Anderson, O. Kornei*, Brush Development Company

CP. Performance Characteristics of Ferrite Recording Heads.** *J. F. Jewett*, Ferroxcube

9:00 a.m. Electronic Systems Reliability

53-208. Reliability in Industrial Electronic Equipment. *E. D. Cook*, General Electric Company

CP. The Human Being in Man-Machine Systems.** *F. R. Naka*, Massachusetts Institute of Technology

CP. Equipment Reliability as Applied to Analogue Computers.** *Herbert Jacobs, Jr.*, Massachusetts Institute of Technology

CP. Achieving Higher Reliability and Accuracy From Electronic Components by Utilizing Components in Parallel.** *P. B. Montgomery*, Goodyear Aircraft Corporation

9:00 a.m. Nucleonics and Power Generation

CP. Major Factors in the Approach to Atomic Power.** *B. R. Prentice, R. G. Lorraine*, General Electric Company

CP. The Nature of Nuclear Power.** *J. W. Landis*, Atomic Energy Commission

CP. Nuclear Reactors for Power Generation.** *R. L. Witzke, J. M. Stein, E. U. Powell*, Westinghouse Electric Corporation

CP. Considerations for Discontinuous-Type Power Regulation of Nuclear Reactors.** *J. M. Harrer*, Argonne National Laboratory

CP. A Photomultiplier Log Level Period Meter for Reactor Control.** *V. G. Shaw*, Westinghouse Electric Corporation

CP. Maintenance Problems With Reactor Auxiliaries and Instruments.** *C. B. Wagner*, General Electric Company

9:00 a.m. Instruments and Measurements

53-294. Generator Stator Copper Temperature Indicator. *A. L. Brownlee, H. E. Brown*, Commonwealth Edison Company

53-205. Integrating Instruments for Simplified Quality-Control Measurements. *D. M. Longenecker*, General Electric Company

53-295. Correction of Frequency Errors in Wattmeters. *J. R. Freeman*, Massachusetts Institute of Technology

CP. Designing a Line of D-C Portable Instruments.** *R. M. Rowell*, General Electric Company

1:30 p.m. Transistor Standardization

1:30 p.m. Switchgear

53-309. Bushing Current Transformers for Oil Circuit Breakers. *R. B. Shores, C. E. Wollerton*, General Electric Company

53-232. Considerations in the Operation of Outdoor Oil Circuit Breakers Under Low Ambient Temperatures. *E. B. Rietz*, General Electric Company

53-233. Hydraulic Operating Mechanisms for High-Capacity Circuit Breakers. *E. E. Briggs, R. D. Hambrick, D. M. Umphrey*, Pacific Electric Manufacturing Corporation

53-234. A New Compressed Air Circuit Breaker for Arc Furnace Switching Duty. *J. E. Schrameck, J. K. Walker*, Westinghouse Electric Corporation

1:30 p.m. Rotating Machinery

53-302. Calculation of No-Load Waveshape of Salient-Pole A-C Generators. *D. Ginsberg, A. L. Jokl*, Engineer Research and Development Laboratories; *L. M. Blum*, National Bureau of Standards

53-303. Factory Testing of Large Turbine-Generators. *R. W. Stevens, M. D. Ross*, Westinghouse Electric Corporation

53-304. D-C Dynamic Braking of Squirrel-Cage Induction Motors. *W. La Pierre*, Columbia University; *N. Metaxas*, Athens and Pireus Electricity Company

53-305. Commutation of Low-Voltage D-C Aircraft Generators. *P. W. Franklin*, Consultant, Naval Air Development Center. Re-presented for discussion

53-306. Leakage-Voltage Characteristics of Insulation Related to D-C Dielectric Strength. *J. S. Johnson, J. W. Clokey*, Westinghouse Electric Corporation. Re-presented for discussion

1:30 p.m. Special Communications Applications

53-202. Automatic Control System With Provision for Scanning and Memory. *N. H. Young*, Federal Telecommunication Laboratories, Inc.

CP. A Carrier-Type Magnetic Tape Recorder.** *L. L. Fisher*, Ampex Electric Corporation

CP. Graphic Analysis of Communications Networks.** *R. L. Mayer*, Pacific Gas and Electric Company

1:30 p.m. Nucleonics and Power Generation

CP. Precision Controls for a Low-Power Research Reactor.** *C. W. George, J. L. Matrone*, General Electric Company

CP. A Simple Electrical Analogue to a Nuclear Power Plant.** *J. N. Grace*, Westinghouse Electric Corporation

CP. Direct Linear Motion in Sealed Systems.** *R. C. Robinson, W. E. McCown*, Westinghouse Electric Corporation

CP. Position Control in Sealed Systems.** *W. H. Esselman, W. H. Hamilton*, Westinghouse Electric Corporation

CP. Present Feasibility of a Nuclear Power Plant.** *T. G. Le Clair*, Commonwealth Edison Company

1:30 p.m. System Engineering

CP. Austrian Power Supply.** *E. J. Schubert-Drinawehr*, Salzburg, Austria

53-255. Tensorial Analysis of Integrated Transmission Systems—IV. The Interconnection of Transmission Systems. *Gabriel Kron*, General Electric Company

53-256. Analysis of Losses in Loop-Interconnected Systems. *A. F. Glimn, L. K. Kirchmayer*, General Electric Company; *G. W. Stagg*, American Gas and Electric Service Corporation

53-209. Loss Formulas Made Easy. *A. F. Glimn, R. Habermann, Jr., L. K. Kirchmayer*, General Electric Company; *G. W. Stagg*, American Gas and Electric Service Corporation

CP. Economic Aspects of European Electric Power Development.** *P. A. Abetti*, General Electric Company

1:30 p.m. Carrier Current

53-204. Series-Resonant Circuits for Carrier Trapping of Resonant Taps. *S. Lubin, N. M. Levinson*, Sprague Electric Company

53-282. Telecommunication Equipment for Power Systems. Developments and Application in Sweden. *U. Hecht*, Allmänna Svenska Elektriska Aktiebolaget; *S. Rodhe*, Telefonaktiebolaget L. M. Ericsson; *H. J. B. Nevitt*, Ericsson Telephone Sales Corporation

CP. Operation of Single-Sideband Power-Line Carrier.** *P. Taylor*, Central Light and Power Company; *B. M. Ray*, Westinghouse Electric Corporation

CP. New Carrier-Current Telephone Equipment for Modern Electrical Utility Communications.** *Paul Crooker*, General Electric Company

CP. Experience and Reliability of Carrier Relaying Channels.** *Carrier Current Project Subcommittee 5*

Thursday, June 18

9:00 a.m. Electrical Safety Standards and Practices

CP. Edison Electric Institute, National Safety Council, American Society of Safety Engineers.** *W. F. Brown*, Consolidated Edison Company of New York, Inc.

CP. National Electrical Manufacturers Association, AIEE.** *H. H. Watson*, General Electric Company

CP. American Standards Association, Canadian Standards Association, National Bureau of Standards.** *W. C. Wagner*, Philadelphia Electric Company

CP. Underwriters' Laboratories, Inc., National Fire Protection Association, National Board of Fire Underwriters.** *Karl Geiges*, Underwriters' Laboratories, Inc.

9:00 a.m. Magnetic Amplifiers

53-283. A Transient Analyzer for Magnetic Amplifiers. *E. J. Smith*, Polytechnic Institute of Brooklyn

53-284. Theory of Magnetic Amplifiers With Square-Loop Core Materials. *H. F. Storm*, General Electric Company

53-215. Problems to Consider in Applying Selenium Rectifiers. *J. Gramels*, Bell Telephone Laboratories, Inc.

53-285. An Application of Magnetic Amplifier Circuits to Perform Multiplication and Other Analytical Operations. *L. A. Finzi, R. A. Mathias*, Carnegie Institute of Technology. Re-presented for discussion

9:00 a.m. Wire Communications

53-221. The L3 Coaxial System. *C. H. Elmendorf, R. D. Ehrbar, R. H. Klie, A. J. Grossman*, Bell Telephone Laboratories, Inc.

53-222. L3 Coaxial System—Amplifiers. *L. H. Morris, G. H. Lovell, F. R. Dickinson*, Bell Telephone Laboratories, Inc.

53-223. L3 Coaxial System—Equalization and Regulation. *R. W. Ketchledge, T. R. Finch*, Bell Telephone Laboratories, Inc.

53-224. L3 Coaxial System—Television Terminals. *J. W. Rieke, R. S. Graham*, Bell Telephone Laboratories.

CP. Compandors for General Use on Wire and Radio.** *R. S. Caruthers*, Lenkurt Electric Corporation

9:00 a.m. Power Generation, Station Design

CP. Modern High-Capacity Steam Generator Protection.** *J. A. Elzi, J. C. Beres*, Commonwealth Services, Inc.

CP. Electrical Safety Features Used for Boiler Protection in Several Large Generating Stations in the Southeast.** *A. H. Mergenthaler*, Southern Services, Inc.

CP. Boiler Protection and Interlocking on the American Gas and Electric System.** *H. C. Barnes*, American Gas and Electric Service Corporation

CP. Operating Protection Devices for a Reheat Pressurized Boiler.** *G. R. Hahn*, Consolidated Edison Company of New York, Inc.

CP. Electrical Safety Features Used for Boiler Protection at Delaware Station.** *E. E. Brown*, Philadelphia Electric Company

9:00 a.m. High-Dielectric-Constant Ceramics

53-235. Dielectric Breakdown of Sulphur Hexafluoride in Nonuniform Fields. *C. N. Works, T. W. Dakin*, Westinghouse Electric Corporation. Re-presented for discussion

53-236. The Effect of Minor Constituents in High-Dielectric-Constant Titanate Capacitors. *W. W. Coffeen*, Metal and Thermit Corporation

CP. Tailoring Ceramic High-K Dielectrics for Specific Applications.** *R. J. Dew, Jr.*, American Lava Corporation

CP. High-K Ceramic Dielectrics Made From Zirconate and Titanate Materials.** *Shelton, Bunting, Kopell*, National Bureau of Standards

CP. New Developments in Ceramic Dielectrics for Capacitors.** *A. K. Das Gupta, K. R. Clark, S. Hedelman*, Solar Manufacturing Corporation

9:00 a.m. Electronic Circuit Principles

CP. Some Physical Considerations in the Analysis of Transistor Transient Response.** *J. J. Suran*, General Electric Company

CP. Temperature-Stabilized D-C Amplifier Employing Junction Transistors.** *Edward Keojian*, General Electric Company

CP. Wide Deviation Frequency-Modulated Oscillator.** *D. J. Gray, V. P. Gurske, W. E. Morrow*, Massachusetts Institute of Technology

CP. Analysis of Power-Distributed Amplifiers.** *P. H. Rogers*, University of Michigan

9:00 a.m. Electronic Instruments

53-298. A Universal Meter for Measuring Voltages at High Impedances, Micromicroamperes, and Insulation Resistance. *W. R. Clark, R. E. Watson, G. C. Mergner*, Leeds and Northrup Company

53-308. Vacuum-Tube Voltmeter Concepts in the Mid-Frequency Range. *G. B. Hoadley*, North Carolina State College

53-244. A-C Null-Type Recorder With Balancing Amplifier Which Provides Damping and Suppresses the Quadrature Component. *A. J. Williams, Jr., J. F. Payne, Jr.*, Leeds and Northrup Company

CP. Design Criteria for Mutual Inductance Micrometers.** *H. Joseph*, National Bureau of Standards

CP. Sheet and Plated Metal Measurements With a Phase-Angle-Type Probe.** *W. A. Yates, J. L. Queen*, National Bureau of Standards

1:30 p.m. Magnetic Amplifiers

CP. Frequency and Temperature Insensitive Regulated Power Supplies.** *M. A. Pahlavan*, INET, Inc.; *A. B. Rosenstein*, University of California

CP. Design Considerations of the Half-Wave Bridge Magnetic Amplifier.** *C. W. Lufcy, H. H. Woodson*, United States Naval Ordnance Laboratory

CP. Magnetic Amplifier Servo Compensation.** *H. H. Woodson*, United States Naval Ordnance Laboratory

CP. An Application of Compensated Half-Wave Bridge Magnetic Amplifiers.** *E. T. Hooper*, United States Naval Ordnance Laboratory

1:30 p.m. Wire Communications

53-203. Protection of Wire Communication Facilities Serving Power Stations and Substations. *T. W. Alexander*, Bell Telephone Company of Pennsylvania

53-225. Co-ordination of M1, N1, and O1 Telephone Carrier Systems. *E. P. Smith, L. P. Cornell, Jr., M. G. Jerome*, Pacific Telephone and Telegraph Company

53-226. The Control of Noise and Crosstalk on N1 Carrier Systems. *A. J. Aikens*, Bell Telephone Laboratories, Inc.; *C. S. Thaeler*, American Telephone and Telegraph Company

53-227. Transmission Design of Intertoll Telephone Trunks. *H. R. Huntley*, American Telephone and Telegraph Company

1:30 p.m. Power Generation, Hydroelectric Systems

53-220. Unique Outdoor Hydroelectric Plant. *H. E. Rhoades*, Northern States Power Company

CP. Important Economic Factors in the Development of Rehabilitation of Small-Capacity Hydroelectric Stations.** *H. H. Brown*, Wisconsin Michigan Power Company; *A. R. Klann*, Allis-Chalmers Manufacturing Company

CP. Progress Report by the AIEE Joint Subcommittee on Application Probability Methods to Power System Problems, Power Generation, and System Engineering**

1:30 p.m. Magnetics

53-259. The Permeability of Silicon-Iron at Very Low Flux Densities. *Eberhard Both*, Fort Monmouth, N. J. Re-presented for discussion

53-260. Stressed Ferrites Having Rectangular Hy teresis Loops. *H. J. Williams, R. C. Sherwood, Matil Goertz, F. J. Schnettler*, Bell Telephone Laboratori Inc. Re-presented for discussion

53-261. Mathematical Description of Core Losse *J. W. Hale*, Allegheny Ludlum Steel Corporatio *F. R. Richardson*, General Electric Company. Re-pr sented for discussion

1:30 p.m. Transformers

53-275. Analytical Approach to the Variable Turn Ratio Autotransformers. *E. Mishkin*, Hebrew I stitute of Technology, Israel

CP. Measurement of Ambient Air Temperatu During Temperature Test on Transformers.** *M. Beavers*, General Electric Company

53-270. Analysis of the Delta Grounded Tran former. *E. T. B. Gross*, Illinois Institute of Tech nology; *K. J. Rao*, Vern E. Alden Company

CP. Modern Forced-Air Cooling of Power Tran formers.** *W. D. Albright*, Westinghouse Electric Co poration

53-276. Special 3-Phase Core Arrangements. *F. Roeding*, Westinghouse Electric Corporation

2:00 p.m. Instruments and Measure ments

53-289. Forcing Function Generator Employin Conductive Plastic. *L. W. Norman*, Minneapoli Honeywell Regulator Company

53-290. A Permeability Analyzer for Magnet Amplifier Cores. *Philip Siskind*, Sperry Gyroscop Company

CP. Basic Theory and Experimental Verificatio of the A-C Galvanometer.** *T. J. Higgins*, Unive sity of Wisconsin; *William Kneen*, Pullman Corporatio

CP. An Emission Characteristic Plotter for The mionic Cathodes.** *Lewis Marzetta*, National Bureau Standards

Friday June 19

9:00 a.m. Communication Switching

53-216. An Application of Boolean Algebra to th Design of Electronic Switching Circuits. *S. Washburn*, Bell Telephone Laboratories, Inc.

53-217. The Map Method for Synthesis of Comb national Logic Circuits. *M. Karnaugh*, Bell Telephon Laboratories, Inc.

CP. Circuit Action Charts.** *A. C. Reynolds*, Inte national Business Machines Corporation

53-218. Transistors and Their Circuits in the 4 Toll Crossbar Switching System. *P. Mallery*, Be Telephone Laboratories, Inc.

53-219. Telephone System Applications of R corded Machine Announcements. *W. Bennett*, Be Telephone Laboratories, Inc. Re-presented for di cussion

9:00 a.m. Transformers

CP. Crepe Papers and Crepe-Paper Cables fo Transformers.** *G. Camilli, L. Mulligan, E. L. Crandal* General Electric Company

53-277. A New Low-Liquid-Content Current Tran former. *L. W. Marks*, General Electric Company

CP. External and Internal Factors Affectin High-Voltage Bushing Withstand Values.** *S. Terpa D. L. Johnston*, General Electric Company

53-278. An Impulse Generator Circuit for Choppe Wave Tests on Transformers. *G. H. Johnson*, Lin Material Company

9:00 a.m. Transmission and Distributio

53-229. Physical Concepts of Corona in Capacitor *J. R. Nye*, General Electric Company

53-257. Puncture Tests on Porcelain Distributio Insulators Using Steep-Front Voltage Surges. *J. Park, H. H. Cones*, National Bureau of Standards

CP. Field Report on a New Surge-Test Oscill graph.** *W. G. Fockler*, Allen B. Du Mont Laboratorie

53-258. Economic Merits of Secondary Capacitor *R. A. Zimmerman*, Westinghouse Electric Corporation

:00 am. Basic Science

-262. The Electric Strength of Air in Nonuniform elds at Radio Frequencies. *J. B. Whitehead, C. F. iller,* The Johns Hopkins University; *D. L. Birx,* he Franklin Institute Laboratory for Research and evelopment

-263. The Electron Ion Recombination Process in ases. *Sidney Borowitz,* New York University. Re-pre-nted for discussion

P. Tracking Response Characteristics of the uman Operator.** *J. I. Elkind,* Massachusetts In-itute of Technology

-265. Applications of Integral Equations to the olution of Nonlinear Electric Circuit Problems. *A. Pipes,* University of California

-266. Flow of Energy in D-C Machines. *E. I. awthorne,* University of Pennsylvania

:00 a.m. Power Generation, Prime Movers

P. Methods of Starting Gas Turbine-Generator nits.** *W. B. Boyum, R. W. Ferguson, J. G. Partlow,* estinghouse Electric Corporation

P. Can Human Engineering Help in Reaching ecisions in Instrumentation and Control?** *B. J. ovner,* Dunlap and Associates, Inc.

P. Generating Plant Costs in 1952.** *A. E. nowlton, Electrical World* Magazine

:00 a.m. Petroleum Industry

P. Modern Electric Distribution System for an il Refinery.** *V. Nealy,* Texas Company

P. Design Factors of Refinery Electric Dis-ibution.** *H. G. Buch,* Socony Vacuum Company

P. Turbogenerators and Heat Balance of Re-nery Applications.** *J. C. Spahr,* Westinghouse Electric orporation

P. High-Voltage Motor Control for Semi-azardous Locations.** *Ray Maynard,* General Electric ompany

CP. Motor Lubrication Practices in an Oil Refinery.** *F. H. Walker,* Atlantic Refining Company

9:00 a.m. Transient Response of Systems

53-247. A Relative Damping Criterion for Linear Systems. *J. F. Koenig,* National Bureau of Standards

53-248. Approximation of Transient Response From Frequency Response Data. *C. H. Dawson,* University of Rochester

53-249. The Synthesis of Optimum Transient Response: Criteria and Standard Forms. *Dunstan Graham, R. C. Lathrop,* Wright Air Development Center

53-250. Bibliography on Feedback Control, Part I. *Subcommittees on Bibliography of the Committees on Industrial Control and Feedback Control Systems*

53-251. Bibliography on Feedback Control, Part II. *Subcommittees on Bibliography of the Committees on Industrial Control and Feedback Control Systems*

1:30 p.m. Radio Communications

53-198. Frequency Generating Equipment for Million-Watt Navy Transmitter. *D. G. Robertson,* Radio Corporation of America

53-199. A Million-Watt Naval Communication Transmitter. *J. C. Walter,* Radio Corporation of America

53-196. Aircraft Protection From Thunderstorm Discharges to Antennas. *J. M. Bryant,* University of Minnesota; *M. M. Newman, J. D. Robb,* Lightning and Transients Research Institute

53-213. The New Jersey Turnpike—A Unique Highway Communication System. *P. F. Godley,* Paul Godley Company; *J. R. Neubauer, D. R. Marsh,* Radio Corporation of America. Re-presented for discussion

1:30 p.m. Transformers

53-246. Temperature Classes for Dry-Type Transformers as Determined by Functional Tests. *Paul Narbut,* Westinghouse Electric Corporation

53-243. Life Expectancy of Oil-Immersed Insulation Structures. *W. A. Sumner, G. M. Stein, A. M. Lockie,* Westinghouse Electric Corporation

53-279. Field Theory of Wave Propagation Along Coils. *H. Poritsky, P. A. Abetti, R. P. Jerrard,* General Electric Company

53-245. Sealed Dry-Type Transformers Proved Safe by Test. *E. W. Tipton,* Westinghouse Electric Corporation

53-280. Propagation Mechanism of Impulse Corona and Breakdown in Oil. *T. W. Liao, J. G. Anderson,* General Electric Company

1:30 p.m. Nonlinear Systems

53-252. Optimization of Nonlinear Control Systems by Means of Nonlinear Feedbacks. *R. S. Neiswander, R. H. MacNeal,* California Institute of Technology

53-253. Open-Loop Frequency Response Method for Nonlinear Servomechanisms. *R. L. Cosgriff,* Ohio State University

53-254. Describing Function Method of Servomechanism Analysis Applied to Most Commonly Encountered Nonlinearities. *H. D. Greif,* Hughes Aircraft Company

CP. The Finger-Type Voltage Regulator.** *T. F. McHenry,* Electric Regulator Corporation

1:30 p.m. Basic Science

53-267. The First-Order Behavior of Separable Oscillators. *D. C. Depackh,* Naval Research Laboratory

CP. Acceleration Plane Method for Analysis of a Circuit With Nonlinear Inductance and Nonlinear Capacitance.** *Y. H. Ku,* Moore School of Electrical Engineering

53-268. Basic Concepts in the Analysis of Stationary Electric Circuits. *D. W. Spence, C. R. Cahn,* Niagara Mohawk Power Corporation

53-269. Block Diagram Solutions for Vacuum-Tube Circuits. *T. M. Stout,* University of Washington. Re-presented for discussion

Southern District Meeting in Louisville Includes Annual Appliance Conference

True to its traditional hospitality, the AIEE Southern District provided excellent are—both technical and social—to the 457 members and guests who attended its meeting in the Seelbach Hotel, Louisville, Ky., April 22–24. A number of inspection trips were taken to near-by industries, power plants, and Station *WHAS-TV.* A total of 15 sessions were held during the days. In conjunction with the District Meeting,, the fourth annual Technical Conference on Appliances was held.

GENERAL SESSION

Professor M. G. Northrop, General Chairman of the meeting, welcomed the members to the general session in the ballroom on Wednesday morning. He introduced George Hendon, the executive assistant to Mayor C. P. Farnsley of Louisville, and after extending a warm welcome to the members, he presented AIEE President D. . Quarles with a miniature flag of the city nd the traditional key. After acknowledging the welcome, Mr. Quarles spoke on veral matters of interest to the Institute n a national level. (Mr. Quarles' address ill be found on pages 477–9.)

The Vice-President of District 4, E. S. ammers, Jr., next addressed the members n "Engineers in the Making."

He first paid tribute to the far-sighted nstitute members of 1903 who started the udent activities. "Those men were wise," he said, "because they realized that the AIEE would need engineers in future years just as the engineers need the Institute; one supplements the other."

He pointed out that there are two fundamentals that make engineers of the future: the facilities of a college—its laboratories, classrooms, proper guidance, and so forth; and the laboratories of industry, where engineers can become familiar with the equipment of engineering. The acquisition of funds to provide these fundamentals constitutes a major problem.

In this respect, District 4 has held its own in producing engineers. It has 18 of the 132 Student Branches of the Institute, and during the last 4 years, twice has won the National Branch Paper Prize.

According to Mr. Lammers, one factor should never change in the making of an engineer: the desire to create and to contribute his best efforts. Engineers cannot be measured as can an assembly line; their engineering life is like a ladder based on the heritage of the past up which they must climb to its top at the pinnacle of success.

F. W. Russell, vice-president in charge of operation, Louisville Gas and Electric Company, discussed the "Recent Power Expansion in the Louisville Area." In 1930 there was but one steam power plant, but since World War II generating capacity in the area has increased 500 per cent over what it was 23 years ago. Mr. Russell described the expansion of the interchange of power and the 154,000-volt lines to the Tennessee Valley Authority, over which last year more than 1,000,000,000 kilowatt-hours went south through the Paddy's Run Terminal. The speaker told how the Louisville company is tied in with the newly formed Ohio Valley combine and about the tests and developments of its projects.

Mr. Russell addressed his closing remarks to the hundred or more students at the meeting, saying that they could not have chosen a better profession and urging them to consider opportunities in the power field.

SOCIAL EVENTS

At a luncheon following the general session, Keen Johnson, former Governor of Kentucky, drew from his vast store of amusing stories in his talk on the increased use of aluminum in today's electrical engineering field and tomorrow's opportunity in power.

On Wednesday evening a reception for members, guests, and students was held followed by a buffet supper and a floor show. The following evening a banquet and dance was enjoyed by members and guests. It was at the banquet that the Student paper awards were made by Vice-President Lammers.

INDUSTRY SESSIONS

Two industry sessions were held with Frank P. Lederer presiding at the first and Mead Warren presiding at the second of these sessions.

In the first session, F. P. Brightman, General Electric Company, outlined the various steps which should be taken to

Pacific General Meeting Site

Vancouver, British Columbia, will be the scene of the AIEE Pacific General Meeting, September 1–4, 1953. Third largest city in Canada, Vancouver is located 15 miles due north of the International Boundary and approximately 140 miles north of Seattle, Wash. The city is built on one of the world's finest natural harbors with spectacular mountain and seascape background. Here, looking north across the harbor to the North Shore mountains, can be seen the Lions' Gate Bridge, longest suspension bridge in the British Empire, and the wooded area of Stanley Park, 1,000 acres of unspoiled forest. The largest building, left center, is the Hotel Vancouver, headquarters for the AIEE meeting

obtain relay co-ordination in industrial plants. The author concluded that operators would profit greatly from making the necessary systems studies. Another paper, which dealt with precise speed control over a wide range of 35 to 117 cycles in a variable-frequency drive for synthetic fiber spinning machines, was presented by Harry Stiltz of the E. I. du Pont Company. A reluctance type of synchronous motor is employed here with intricate control circuits. Still another paper in the field of textiles described several applications of electronic equipment for speed control, counting, and dielectric heating for drying. The author, Robert Posey of the Westinghouse Electric Corporation, cautioned against the use of electronic equipment if good standard industrial equipment is available because the maintenance of electronic equipment requires trained personnel.

Two of the papers were mathematical in nature. J. A. Granath and A. K. Hawkes, in a paper on power equalizer systems for aircraft alternators, worked out analytical expressions for the voltage and frequency in a 400-cycle system where real and reactive load division are accomplished by equalizer systems. The expressions enable the prediction of regulated quantities during an unbalanced condition on a more precise quantitative basis than has been possible heretofore. In the other paper, W. A. Stein of the United States Naval Postgraduate School derived formulas for determining rotor resistance and leakage reactance in reference to the stator winding for a drag-cup servomotor.

Another paper dealt with the advantages of multitransformer welding presses in the mass production of large fabricated parts.

In the second industry session, most of the papers were related to applications in mining work. Such problems as alternating versus direct current for underground mining, the electrical hazards of coal mining, and the technical aspects of electric equipment applications in coal preparation plants were discussed. Other papers dealt with outdoor motor enclosures, the grounding of industrial power systems, and a mechanism for the fuse prearcing period.

POWER

In the field of power, 11 papers were presented in two sessions which dealt with a broad variety of problems, such as the economics of fan cooling of transformers, the measuring and recording of small voltage variations produced by variable loads, and the design of a dispatching office. Still other papers had to do with the shape-correction factors for calculating short-circuit forces of busses composed of double-channel conductors and the restraining of the repulsive forces in large duplex current-limiting reactors.

In the second power session, papers were presented concerning the skin-spiraling effects in stranded conductors, the results of operating experience with connectors for alum num conductors, and a direct method f sag-tension calculations.

In another paper, the duty of expulsio type lightning arresters for distributi systems was analyzed and in still two oth papers, an ingenious method of curren transformer design was brought forth as we as improved current-transformer desig made possible by the use of cold-rolled high permeability steel and the proper applic tion of high-strength paper insulation.

GENERAL

For those interested in culture ar laboratory research, a session of five pape was offered on Thursday afternoon. Th first two papers were concerned with th power-system test facilities and electr equipment in the Arnold Engineerin Development Center. Another paper d scribed the new features incorporated in th new electrical engineering laboratories the University of South Carolina. Tw other papers treated electric power as creative force in North Carolina and educ tion and training for a living.

COMMUNICATIONS AND ELECTRONICS

In these fields, three sessions were held W. J. Worthman presided over the firs J. L. Fulmer presided over the second, ar Stuart Gates was chairman of the third.

In the first session, William Dodson of th American Air Filter Company presente three methods for the measurement of spa charge. In a paper by Dean E. A. Walk and J. E. Coolidge, Jr., the laborato results of an electrostatic precipitation stud were presented. In another paper, T. Wilson of the Girdler Corporation outlin the numerous design problems in th development of dielectric heating equi ment. Slides were shown of the pol pattern obtained when testing the effectiv ness of shielding against radiation on install tions which indicated results as low as 0 microvolt per meter at a distance of 1 mil The Federal Communications Commissio requires that radiation must be below microvolts per meter at this distance.

In still another paper, by Shizuo Ho Armour Research Foundation, and Profess T. J. Higgins, University of Wisconsin, exa numerical values were worked out for th capacitances of a coaxial, rectangula cylindrical transmission line.

The development of an electronic mul plier capable of delivering an output volta which is proportional to the instantaneo product of two alternating voltages w described in a paper by E. L. Peterson Tulane University. The last paper, whi discussed the influence of shunt capacitan variations upon the performance of se saturating magnetic amplifiers, was pr sented by Chang Yun of the Allis-Chalme Manufacturing Company.

In this second session on Communicati and Electronics, C. A. Armstrong, Americ Telephone and Telegraph Company, re his technical paper, "Communications f Civil Defense." (A revised version of th paper will be found in the March 19 issue of *Electrical Engineering*, pages 218–2 H. L. Foote, Stromberg-Carlson Compan read "The XY Toll Ticketing System which appears in this issue, pages 517–22.

Two District and three technical pap

were given at the third session. G. A. Holt, Atomic Energy Commission development engineer, presented the first District paper, "Design Criteria for Tube Aging and Tube Testing at Oak Ridge National Laboratory." After reviewing the vacuum-tube situation in the broadcast- and television-receiver fields today, the author stressed the necessity of having available tubes of much greater reliability for computers and nuclear-reactor control equipment. He described several "aging" circuits which have been used for the "screening" and aging of tubes before being used in vital instruments.

W. C. Burnett, Southern Bell Telephone Company, read the second District paper, "Radiotelephone From Wilmington to Shallotte, N. C." This paper dealt with the experience of the telephone company in adapting equipment of the mobile radiotelephone type to the provision of telephone service in a remote area of North Carolina which had none.

The first of the three technical papers, "Path Testing for Microwave Routes," was presented by R. D. Campbell, American Telephone and Telegraph Company. The author described methods for determining and testing the optimum locations of antennas for the transmission and reception of microwave signals and the interference effects of different types of terrain in the paths. (A revised version of this paper is scheduled for the July issue of *Electrical Engineering*.)

W. W. Macalpine, Federal Telecommunications Laboratory, presented a mathematical paper, "Computation of Impedance and Efficiency of Transmission Line With High Standing Wave Ratio," and the final technical paper, by E. G. and E. O. Gilbert, University of Michigan graduate students, was "A Capacitively Coupled Field Mapper for 2-Dimensional Distributed-Source Field Problems." By the use of a special paper, "Teledeltos," and an ingenious electronic circuit, the authors showed how a field of any configuration could be plotted with remarkable accuracy.

APPLIANCE TECHNICAL CONFERENCE

The opening session of the Appliance Conference, which had as its theme, "Appliance Control Components," was held on Wednesday afternoon in the Grand Ballroom. T. H. Cline, Chairman of the Committee on Domestic and Commercial Applications, in his welcoming remarks stated that this, the fourth annual Appliance Conference, was a continuation of last year's conference on controls inasmuch as the subject was so broad that much more remained to be discussed at the close of the third conference.

R. W. Gustafson, General Electric Company, read the first paper, "New Oil Burner Heat Control." A thermal timer type, this control's cost is low and it is adaptable to standard units and systems. It can be used with remote flame detection or built into the stack switch type of control. The transformer and relay are combined in one device; the thermal timer is enclosed and ambient compensated; and the flame detector is a simple clutch-operated device.

"Evaluation of Performance for Appliance Controls" was presented by G. C. Pearce, Frigidaire Division of General Motors Corporation. In this paper, the author discussed the various techniques which have been developed for testing timers for washers, ranges, and refrigerators; thermostats; and for the various components of appliances which showed too short a life.

V. V. Savolainen's paper, "Reversed Thermostat Metal," was read by R. M. Sears, General Plate Division, Metals and Controls Corporation. After a discussion of the properties of the metals and the methods of fabrication, the author described the various forms in which these thermostats are used in appliances.

Frank Spayth, P. R. Mallory Company, presented "Electrical Contacts." After enumerating the five basic contact problems—contact resistance, erosion, transfer, sticking or welding, and energy dissipation—the author discussed each one and then told about the different types of contacts.

The final paper of the session, "Fundamentals of Bimetal Performance," was presented by C. F. Alban, W. M. Chace Company, in which were given equations for calculating the properties of the thermostatic bimetals and their applications.

The second session of the Appliances Conference, at which T. T. Woodson was chairman, was opened by A. P. McNamee of *McCall's* Magazine, who spoke on "Kitchen Layout Studies." This was a résumé of a kitchen-designing contest in which more than 18,000 women expressed their preferences for kitchen appliances, furnishings, and arrangements.

A. B. BecVar, General Electric Company, presented "What Does Design Mean to the Customer?" Good design expresses good quality, good engineering, and easy sales, the final design of a product being a selection of ideas submitted by all the departments of a firm which have anything to do with the making and marketing of the product. Good design is a happy medium struck between lavishness and the aesthetic.

"Static Nonlinear Elements for Appliance Control" was read by B. H. List, coauthor with R. C. McMaster and R. L. Merrill, all of Battelle Memorial Institute. It was brought out that as appliance controls become more complex and more costly, the designer should consider static nonlinear elements, such as magnetic amplifiers, thermistors, transistors, germanium and silicon diodes, and dielectric amplifiers, which are finding increased use in many fields of electronics and industrial control.

The history of dishwashing machines over the last century was traced by G. H. Wotring, General Electric Company, in his paper "Dishwasher Controls." In 1918, an electric drive was added and 4 years later an automatic sequencing control was marketed. Mr. Wotring described the latest dishwasher controls and told of some of the unsolved problems.

The final paper of the session, "Grounding Plugs and Grounding of Appliances," was given by G. C. Mapelsden, General Electric Company. The author reviewed the present state of appliance grounding requirements together with the devices available and the reasons for grounding.

Role of Fuses, Circuit Breakers, and Thermal Overloads in Appliance Protection. The climax of the Appliance Technical Conference was a symposium in which papers by six experts presented the "Role of Fuses, Circuit Breakers, and Thermal Overloads in Appliance Protection." In the panel discussion which followed, M. M. Brandon, Underwriters Laboratories, Inc., acted as moderator.

The first paper, "Motor Overload Protection for Domestic Appliances," by W. H. Farrell of the Underwriters' Laboratories, served admirably as an introduction as it pointed out from an analysis of fires of electrical origin which occurred in 30 large cities throughout the United States in 1951 that 32.7 per cent of these fires were due to motor burn-outs. The author reviewed the conditions under which the Underwriters' Laboratories, Inc., has required thermal or overcurrent protection for motors in domestic appliances, conditions under which an appliance has been considered to be automatically controlled, conditions under which a hazard has been considered to exist, and new conditions in the appliance which may be introduced by the installation of an overload protective device. The specific applications where motor protection has been required on appliances were outlined.

The second paper, "Branch Circuit Overcurrent Protection for Appliance Loads," was presented by F. G. VonHoorn of the General Electric Company. The subject was discussed from the point of view of three typical types of branch circuits and their protective devices: 1. general-purpose lighting and appliance branch circuits; 2. special branch circuits supplying a single fixed appliance; and 3. motor branch circuits.

The third paper gave the results of a field survey of the role of inherent overheat protection in appliances and was presented by E. P. Jastram, Jr., Spencer Thermostat Division, Metals and Controls Corporation. A traveling laboratory which visited motor repair shops throughout the southern states made this extensive field survey. The results indicated that 80.2 per cent of all burned-out motors examined were without inherent protectors, 14.4 per cent of all burned-out motors had other makes of inherent protectors, and 5.4 per cent examined had Klixon inherent protectors. The authors concluded that field surveys to date indicate that inherent protectors reduce burn-outs among motors coming into repair shops by a factor of 80 per cent.

The fourth paper dealt with "Role of Fuses in Appliance Protection" and was presented by J. C. Lebens of the Bussman Manufacturing Company. The author discussed the characteristics of fuses and the selection of the proper type of fuse for the protection of the appliance and cord. Particular emphasis was laid on the time–current characteristics of the 100-ampere 250-volt dual-element fuse and the ordinary 1-time fuse. In conclusion, the author stated that the fuse manufacturers have available time–current characteristics of the various types of fuses they manufacture, which makes the selection of the proper fuse for a given appliance a relatively simple job.

The fifth paper was entitled "Miniature Fuses for Protection of Appliance Circuits" and it was presented by A. J. Steele of Littlefuse Inc. The author described the development of miniature fuses, and a comparison of the various types of fuses was drawn, as well as a comparison of miniature fuses and service circuit breakers. For discussion by the forum, the author recommended that inasmuch as the *3AB* fuse

must stand up under the same tests as branch circuit fuses, his company feels that the *3AB* fuse should be allowed the same privilege of application as the branch circuit fuses. If not allowed privileges of application comparable to branch circuit fuses, the author recommended that the test specification of Underwriters' Laboratories be made comparable to that of auxiliary or service-type circuit breakers.

The sixth paper, entitled "Overload and Overcurrent Protection of Motorized Appliances and Their Branch Circuits," was presented by G. W. Heumann of the General Electric Company. The author reviewed the causes of motor overheating, thermal overload relays, short-circuit protection, and he explained the design and tripping characteristics of the molded cased air circuit breakers.

Discussions. Among the many interesting questions raised, R. Fauquet, Sears Roebuck and Company, inquired as to the reason why automatic washing machines have been required to have overload protection only if the capacitor-type motor is employed. W. H. Farrell explained that capacitors were not always too reliable and that additional tests had been run. This requirement has been in effect for a considerable period of time.

In connection with automatic dishwashing machines, L. L. Miller, Bendix Home Appliances, suggested raising the 125-degree-centigrade temperature limit on motor windings under running overload conditions when 150 degrees centigrade protection had been put in against locked rotor conditions. G. C. Mapelsden of the General Electric Company pointed out that the automatic dishwasher would require this protection only if it could be demonstrated that the motor could be overloaded. J. C. Worst of the General Electric Company pointed out that the washing machine motor is protected by a clutch. L. Tulauskas of P. R. Mallory and Company explained that the manufacturer of the machine used a fluid coupling and Mr. Farrell explained that if there was no question of overload running that protection would not be required.

In respect to the point raised in Mr. Steele's paper for discussion to the effect that *3AB* fuses should be allowed the same privilege of application for branch circuit protection, M. Brandon of the Underwriters' Laboratories introduced the matter as follows: He explained that around 1900–1904 there was considerable confusion in the industry about the size of fuses and that Edison had developed an open-link fuse at that time. Every manufacturer had his own ideas about fuses so industry got together and developed an agreed-upon industry standard which was put in the code. The answer to the question was a matter of standardization which would have to go to the National Electrical Code Committee. J. C. Lebens of the Bussman Manufacturing Company stated that their position in the matter was that fuses beyond the 20-ampere sizes required special attention and when used in panelboard in the home, they would not receive that attention. T. H. Cline, Chairman of the Committee on Domestic and Commercial Applications, explained that there were many outlets in electric ranges where protection was provided by standard plug fuses which are difficult to find and reach and he expressed the belief that the ideal thing to use would be miniature fuses. He believed there should be some recognition for the use of these fuses in special applications.

STUDENT ACTIVITIES

Two well-attended student sessions were held in which 12 papers were presented by the students. The District Branch First Prize was awarded to H. W. Thompson, Jr., and S. H. Wesley, Jr., of North Carolina State College for their paper entitled "Problems in Crystal Manufacturing." The District Branch Second Prize was awarded to L. F. Goeller, Jr., of the University of Virginia for his paper entitled "Design of Broadcast Consolettes for Announcer Use." The awards were announced by Vice-President Lammers at the dinner on Thursday evening. The winners of the first prize will be entitled to a trip to the Summer General Meeting at Atlantic City, N. J., with expenses paid from the Members-for-Life fund.

A luncheon meeting of Student Branch Counselors was held on Thursday followed by a student business session on Friday morning. In addition to attending the evening social functions, many of the students also went on an inspection trip to General Electric Appliance Park. The papers presented at the two student sessions were as follows:

Student Sessions

Wednesday, April 22, 2 : 00 p.m.

Homopolar D-C Generator. *Hardy Ross Stone III*, Mississippi State College

Using the Oscilloscope for Accurate Phase-Angle Measurements. *W. C. Yenget*, Duke University

The Design of a Tick-Tack-Toe Machine. J. L. *Kaiser*, University of Kentucky

Problems in Crystal Manufacturing. *H. W. Thomp-son, Jr., S. H. Wesley, Jr.*, North Carolina State College

Power Generation From the Wind. *H. J. Boisseau, Jr.*, Tulane University of Louisiana

The Theory of Information and Its Application t Electronic Computers. *R. L. Simms, Jr.*, Universit of Louisville

Thursday, April 23, 9 : 00 a.m.

A Cathode-Ray Oscillograph for Recording Non recurring High-Voltage Transients. *W. F. Sarles, Jr., J. R. Stewart, W. B. Wright*, Duke University

Quality Control of Electronic Components for Use i the Proximity Fuse. *Raymond Lorenzini*, Vanderbil University

Design of Broadcast Consolettes for Announcer Use *L. F. Goeller, Jr.*, University of Virginia

Determination of Temperature From the Velocity of Sound. *J. B. Hudson*, University of Kentucky

Photoelectric Complex-Wave Generator. *G. W Megginson, T. R. Hudson*, University of Alabama

Voltage Analogues of Differential Equations. *D. W Mitton*, North Carolina State College

COMMITTEE

The chairmen of the Southern District Meeting Committee which made the arrangements were as follows: General, M G. Northrop; Vice-Chairman, J. G. Lips Secretary, Joseph D. Warren; Finance W. J. Ryan; Registration, J. F. Gregory Hotels, H. T. Smith; Equipment, T. W Talcott; Entertainment, J. D. Caudill Publicity, O. W. Towner; Transportation R. D. Spaulding; Inspection Trips, W. B Watkins; Student Activities, Professor S. T Fife; Printing, J. M. Houchens; Sports L. G. Weiser; Ladies, Mrs. J. G. Lips.

The chairmen of the Appliance Technical Conference committees were: Technical Program, T. T. Woodson; Finance, L. H Gottliebsen; Registration, R. A. Rosenkrans; Equipment, S. B. Welch; Publicity W. F. Kindt; Transportation, E. A Zuercher; Inspection Trips, A. M. Anderson

Boston Section Anniversary Highlights 1953 North Eastern District Meeting

The Golden Jubilee of the AIEE Boston Section was celebrated with a 3-day meeting at the Sheraton-Plaza Hotel starting on April 29 in the Hub City. Nearly 850 members and guests participated in the festivities and technical sessions. Concurrently with this North Eastern District Meeting was the Northern Textile Conference on May 1 at which the attendance was 70 members and guests.

Eleven technical sessions were on the program at which 30 papers were given; four papers were read at the Textile Conference; and at the Thursday morning General Session three addresses were enjoyed by the large audience. On Wednesday evening a cocktail party and dinner followed by vaudeville entertainment was enjoyed by the members and the following evening the banquet guests were addressed by A. C. Monteith, vice-president of the Westinghouse Electric Corporation, after which there was dancing.

The Western World must depend upon the engineer for its defense "because in manpower alone we are hopelessly outnumbered." Addressing the banquet guests, Mr. Monteith warned against an increasing shortage of engineering manpower and urged the intensification of programs to increase the supply of engineers. Americans must realize that a soldier in Korea is a "sitting duck" unless he is backed up with highly technical fighting tools, Mr. Monteith said. He emphasized that to provide these vital arms, "we must have strong, continuing programs of research and development."

To illustrate how short the supply o engineers is today, Mr. Monteith cited a report by the Survey Committee of Engineers Joint Council that a supply of about 30,000 graduate engineers is needed each year for normal industry operation, with another 12,000 required for defense needs Of this total of 42,000 needed, the colleges are graduating about 21,000 this year—hal of the number actually in demand Although these figures summarize the shortage of engineers rather neatly, they do no show altogether the seriousness of the problem. For example, industry has a backed-up demand for more than 50,000 engineers today.

Furthermore, he said that there are indications that the number of engineering

raduates in future years will decline because f a number of factors in education such as he shortage of science teachers and the nadequate preparation of high-school stu-lents for engineering work.

The Westinghouse executive pointed out hat there is "nothing startlingly new about hese figures" on the acute shortage of ngineers and that the engineering pro-ession has been aware of it for some time. To combat the shortage, he declared, engi-neering societies and industry have joined ogether in a number of programs aimed at ncreasing the supply of engineers through etter utilization of engineering talent, nore scholarships, work-study plans, and he like.

The ladies were entertained by a varied rogram with trips to historic points of in-erest of which Boston has so many. At noon on Friday the members attending the all-day Textile Conference enjoyed a lunch-eon address by Robert Browning of Booz, Allen, and Hamilton.

GENERAL SESSION

The General Session was held Thursday morning in the Ballroom and AIEE Past-President C. A. Powel, Massachusetts Institute of Technology, presided. He an-nounced the North Eastern District (1) prize paper winners, awarded by the District Executive Committee. The first prize of $75 was awarded to P. A. Abetti for "Trans-former Models for the Determination of Transient Voltages" and the second prize of $50 to J. T. Blake, D. W. Kitchin, and O. S. Pratt for their paper, "Microbiological Deterioration of Rubber Insulation."

Mr. Powel then read "A Tribute to Elihu Thomson," the meeting being on the centenary of Thomson's birth. The speaker traced Professor Thomson's association with the early days of the General Electric Company and the Massachusetts Institute of Technology of which he was acting president during 1920–22. Professor Thom-son was the fifth AIEE president in 1889.

Dr. Lawrence R. Hafstad, Director of Reactor Development, United States Atomic Energy Commission, gave "A Progress Report on Atomic Power." After describing the basic chemistry involved in atomic fission and how 2,600,000 pounds of coal have the same energy content of 1 pound of uranium 235, he explained the functioning of a reactor and the problems which the engineer must overcome before an eco-nomical power reactor will be practical, as it is not feasible in its present stage.

Materials of which power reactors are built must stand temperatures between 1,000,000 and 10,000,000 degrees centigrade; they must not absorb neutrons, for example aluminum, stainless steel, and zirconium; and they must stand up under intense radiation. In a nuclear power plant, the coolant becomes radioactive and it is from this radioactive liquid that heat is extracted to furnish heat to the electric power plant boiler.

There is sufficient uranium in the world for a power program, but there is a question: By the time we can produce electricity economically by a breeder reactor will we have learned to use solar energy instead? It is impossible at present to foretell when nuclear reactors will become economically

Featured speakers at the General Session were Dr. Lawrence R. Hafstad, United States Atomic Energy Commission, and Karl T. Compton, Massachusetts Institute of Technology. Left to right are: Mr. Compton; F. B. Haeussler, General Chairman; C. A. Powel, and Dr. Hafstad

practical, as plutonium is a product along with the heat and the cost and value of plutonium being classified at present, we cannot estimate what its price will be in the future.

The final address of the meeting, "Nuclear Research: in Retrospect and Prospect," was made by Karl T. Compton, Corporation Chairman, Massachusetts Institute of Technology. The speaker traced briefly the history of radioactivity from its discovery in 1896 by Becquerel through Sir Ernest Rutherford's discovery in 1920 that hydrogen could be knocked out of nitrogen leaving oxygen by the bombardment of alpha particles emitted by radioactive substances, and up to the establishment of chain reaction in December 1942.

At the end of World War II, it was imperative that the United States maintain its sole control of atomic weapons and the methods by which they might be produced. Now the situation is different. We and our Canadian and British allies no longer have the monopoly of atomic weapons. Some of the provisions of our Atomic Energy Act have stood in the way of our co-operation with our allies and also in the way of entrance of private initiative into the atomic energy field. These changed situations suggest that the Atomic Energy Act be reviewed and amended to make it the most effective base for our security and national advantage in this field under the circumstances which exist now and in the foreseeable future. It is the consensus of people who are familiar with the field that there be a more realistic handling of the matter of secrecy in the atomic energy field and that there be an opportunity for incentives to private enterprise to become a participant in these developments.

TECHNICAL SESSIONS

Two District papers on transistors were presented Wednesday morning at a session over which W. F. Potter, New England Telephone and Telegraph Company, presided. "Basic Principles of Transistor Electronics" was given by M. Sparks and the second paper was given by R. L. Wallace, Jr., whose subject was "Transistors as Circuit Elements." Both speakers are with the Bell Telephone Laboratories, Inc. Mr. Sparks reviewed the chemistry of transference of electrons and ions in solids and explained how the impurities of germanium are important in the functioning of transistors; how at room temperatures electrons are freed in transistors the same as electrons are when emitted from a hot filament in a triode; and described the growing of germanium with aluminum and arsenic.

Mr. Wallace described the types of transistors used in various circuits and explained how the transistor's negative impedance characteristics are useful in oscillators. Illustrating how important transistors can be in miniaturization, he showed a 10.5-megacycle-band amplifier of 15 components in a 1/8-inch tube $1\frac{1}{2}$ inches long and a frequency-modulated transmitter and microphone which was attached to his shirt collar and used during his talk.

At the Wednesday morning session on relaying, presided over by H. L. Goodridge, the use of microwaves for power-system protective relaying was advocated by H. W. Lensner, Westinghouse Electric Corporation, if certain conditions exist: 1. A line-of-sight path may be established; 2. The carrier spectrum is filled; 3. Losses at carrier frequencies are large; 4. There is an economic advantage.

As the number of channels required increases, a "break-even" point is reached, beyond which any additional channels can be provided for most economically by the microwave system.

George Steeb, Niagara Mohawk Power Corporation, presented an unconventional method of relay protection for a 100,000-kva transformer and generator, in the unit generator-transformer station system. The following criteria were considered in its design:

1. It must be simple, as such a protective scheme is more reliable, requires less material, is easier to check, is less expensive, and is less hazardous.

2. A study of possible fault conditions was made first; the electrical scheme then followed.

In the discussion on Mr. Steeb's paper, it was brought out that the more usual differential-relay system of protection uses single-purpose relays, which do not require setting. Mr. Steeb replied by the assertion that multiplicity of purpose was an advantage, providing back-up protection, short-circuit protection, and detection of series unbalance, without additional equipment.

W. C. Morris and L. E. Goff, General Electric Company, in their paper said that the ideal relay for generator protection against unbalanced faults is one which responds only to the negative-phase-sequence current, and whose time–current characteristic is parallel to, but slightly lower than, the heating characteristic of the machine. They developed such a relay

R. L. Wallace, Jr., (second from right) Bell Telephone Laboratories, explains a miniaturized transistor amplifier to General Chairman F. B. Haeussler (left), M. Sparks of the Bell Laboratories, and W. F. Potter (far right) of the General Advisory Committee

which would bring relay practice into line with the proposed revision to the rotating electric machinery standard concerned with short-circuit requirements. Questioned on whether imbedded resistance or vibration methods could not provide equal protection at less cost, they said that the negative-phase-sequence-overcurrent relay was best when a generator required individual protection.

Magnetic amplifiers, having a power range from thousands of kilowatts to a fraction of a microwatt, have developed so rapidly since the last war that they now rival the electron tube itself in many applications, Dr. T. S. Grey, Massachusetts Institute of Technology, chairman of the session, said in his introduction.

Dr. E. L. Harder, speaking about power controllers, stated that the requirements of a regulating device to control the mass production of quality products were: 1. High gain and very fast response; 2. Very simple construction; 3. Rugged, reliable, and long-lived construction; 4. Infrequent need for servicing; and 5. No circuit adjustments needed once installed.

The magnetic amplifier answers these requirements and, in addition, is ready to go at the flip of a switch, has no moving parts, and needs only a few simple adjustments on installation. These qualities make the device superior, in a large number of applications, to other amplifiers, he said. As a power amplifier, it has been applied in: control of tandem steel-rolling mills; tension regulators and reel drives; control of ignitron rectifiers; voltage regulation for aircraft and synchronous machines; paper mill and lumber carriage drives, and so forth.

H. M. Ogle, General Electric Company, discussed the amplistat, or self-saturating type of magnetic amplifier. Power is consumed in the input winding, as all magnetic devices require ampere turns for operation; however magnetic circuits are often easier to design and have inherent galvanic isolation.

The factor of power separates the device into two types, the signal-power, and the output-power amplifier. The former has as variables gain, stability, linearity and speed of response, only one of which may be optimized. Power gain is the most fundamental, current gain the most useful variable. Circuit techniques for the signal-power type include feedback, push-pull operation, and multistage operation. In the output-power type, sufficient power, efficiency, minimum current, bias, and feedback are the criteria for optimum performance. In the discussion, Richard Spencer, Massachusetts Institute of Technology, demonstrated a junction transistor–magnetic amplifier device, which provides phase control similar to that of a thyratron.

The use of magnetic amplifiers in digital computers was described by D. A. Buck, Massachusetts Institute of Technology. Mr. Buck distinguished between two types, the saturable inductor and the saturable transformer, the use of one or the other being governed by the power-supply and load impedances.

Two circuits were shown, an in-line and a configuration circuit, using toroidal-core amplifiers and germanium-diode rectifiers. Both were based on the binary number system. Thirty-two channels can be provided in a configuration circuit of a size smaller than that using four miniature electron tubes, which would provide only eight channels, and would need much greater auxiliary power to operate.

The main limitation in the use of magnetic amplifiers in computers is the limit of speed; as the megacycle region is approached, core heating becomes prohibitive, and the rectifier does not respond fast enough. Ferrite cores, possessing very high resistivity, have reduced the losses; however, both eddy current and hysteresis loss increase with frequency in such cores (as contrasted with metallic-ribbon cores, where only eddy currents increase).

If the rectifier problem can be solved, the use of magnetic amplifiers in computers should become competitive with electron tubes, Dr. Buck concluded.

Two District papers were presented at the session at which power system communications was considered, and over which A. L. Davis presided. The first part of the paper, "Automatic Load-Frequency Control Via Power-Line Carrier on the New England Electric System," was read by R. E. Minkwitz and the second part by L. G. Eaton, both of the New England Power Service Company. The first part of the paper dealt with the load area of the company—all the New England states except Maine—and the means whereby the automatic control equipment maintains a uniform load on the regulating stations resulting in close schedule of power interchange on the tie lines. Mr. Eaton's part of the paper described the push-to-talk party-line type of telephone system used and the frequency distribution for the telemetering and load control channels.

The second paper of the session, "Communications on the Central Maine Power Company System," was by Basil Payne and A. H. Rogers, Mepsco Services, Inc. The paper described the telephone, supervisory control, carrier-current equipment, and mobile radio facilities used in the Main system.

Four District papers were presented at the session dealing with productive maintenance over which G. J. Delehanty presided. H. F. McCullough, General Electric Company, in his paper, "The Key to Productive Maintenance," traced the rate of this country's population growth for the past 50 years, in the fall of 1952 there being a record-high population of 157,000,000 people. An estimate by the Bureau of Census is that by 1960 this figure will rise to 180,000,000. This population increase will mean a greater demand for all sorts of products and that the yearly output per employee must be increased 16 per cent to meet this demand. He showed that from 1899 to 1949, this country's workers have increased from 5 to 12.3 millions, the average work week has decreased from 60 to 40 hours, and the kilowatt-hours used annually by each worker has increased from 300 to 13,000. An estimate for 1959 was given: the workers will increase to 13 million and the work week will be shortened to 38 hours; the estimated electric power demand will be 20,000 kilowatt-hours per worker per year. Our economic securi

Left to right: General Chairman F. B. Haeussler, W. C. White, A. C. Monteith, and W. S. Hill, Vice-Chairman of the General Advisory Committee, look over the banquet menu

epends on productivity. The more com-lex machines in use today must be main-ined constantly to prevent breakdowns nd consequent monetary loss to fulfill the emands of the future.

N. L. Danforth, St. Regis Paper Company, resented "Preventive Maintenance in a aper Mill." He described the procedure f inspecting new motors and their main-enance; how lubricants are cared for before sing, how the system of preventive main-enance for all electric equipment is recorded, nd how these records have proved an conomy.

"Maintenance Including Engineering in Rubber Plant" was given by C. E. Ross, ood Rubber Company. The author out-ned the maintenance program in the ompany's trade shops, truck repairs, eleva-rs, public-address system, and sanitation, s well as the maintenance of the electric ower equipment used throughout the lant.

The final paper of the session, "Modern levator Maintenance," was given by L. K. nowdon, Westinghouse Electric Corpora-on, who described and analyzed his ompany's available elevator service which divided into general repair, maintenance, nd modernization.

High-voltage transmission was discussed t a session at which H. R. Tomlinson resided.

L. E. Saline, General Electric Company, dvocated the use of voltages above 230 kv r power transmission, making use of the ld 138-kv and 69-kv lines for subtransmis-on. Dr. Saline said the trend is to the ackbone type of system, larger-size con-actors, heavier loadings, and compensation r transient stability problems.

The problems encountered in constructing lectric power crossings over water were ecounted by H. N. Furlong and L. O. Vaite, Stone and Webster Engineering orporation. The largest crossing, over ootenay Lake, Canada, required a clear able span of 10,656 feet, which is the ngest such span in operation. (A 12,000-ot span is, however, under construction cross the Messina Straits from Calabria Sicily.) The possibility of introducing conomies by use of existing utilities, such as ailroad bridges, was emphasized, and the se of 3-legged towers advocated where ettlement might occur.

A. A. Johnson, Westinghouse Electric orporation, warned engineers that, as the se of electric power has been increasing xponentially, 175,000,000 kw should be xpected by 1965; therefore, planning in dvance for such capacity is vital. General ules for such planning are: prepare an deal, long-range system plan; make use f existing equipment as much as possible; ecide how existing facilities may be fitted nto the ideal plan; make each change or ddition so that it fits into the ideal plan; nd modify the ideal plan to match changing oad requirements.

A Student paper session was held on riday morning.

The North Eastern District Prize Paper ompetition was won by Theron Usher, Jr., ale University, who presented a paper on n original method to determine multiple me constants experimentally. Second prize inners were D. R. Collins and A. E. anz, Cornell University, who described eir method of positional-feedback control,

Participants in the Northern Textile Conference, held during the North Eastern District Meeting, were, left to right: R. A. Hudson, Saco-Lowell Shops; S. Cowan, Chairman, AIEE Textile Subcommittee; C. F. Hedlund, Associated Factory Mutual Insurance Companies; R. J. Demartini, F. C. Huyck and Sons; R. Browning, Booz, Allen and Hamilton; L. A. Runton, Alexander Smith, Inc.; V. F. Sepavich, Crompton and Knowles Loom Works; G. W. Knapp, General Electric Company

using a phasitron. The third place award went to L. R. Doyen, Northeastern University, for a review of the application of Chladni patterns to the vibration analysis of turbine wheels and buckets. The judges were Professor J. L. Warner, Tufts College; G. R. Blake, Westinghouse Electric Corporation; and Professor C. L. Dawes, Harvard University. The chairman of the Student paper session was Professor R. G. Porter, Northeastern University; Chairman, District Committee on Student Activities. A luncheon of the chairmen, Student counselors, and Student finalists was held after the meeting.

Industrial process control was the subject of the last session of the meeting. M. A. Princi, chairman, said in his introductory remarks that this was the first such session held at a District meeting. He stated that industrial control tended to lump other sessions together, because of the use by the industrial engineer of ideas and techniques from many branches of engineering.

The country's total investment in instrumentation was estimated by J. R. Ghublikian, Stone and Webster Engineering Corporation, to be 1.3 billion dollars, an increase of twice that prevailing just after the last war. Now, the cost of instrumentation is from 5 to 10 per cent of total plant investment. This increase has been characterized by an accelerated use of electric instruments, at the expense of the pneumatic types.

Mr. Ghublikian said that the more common types of control included temperature, pH, and conductivity measuring apparatus. He then showed how such controls are applied in the chemical process industry.

Dr. H. M. Paynter, Massachusetts Institute of Technology, demonstrated three practical methods to compute the response of closed-loop systems. The first was graphical analysis by the slope-line method of trapezoidal integration, which will solve any differential equation of any order approximately; the approximation being limited only by the thinness of the template used to draw the slope lines.

The second method was numerical, depending on discrete, linear operations, which change all differential equations into algebraic ones.

A third method, using analogue computer elements, was advocated by Dr. Paynter where continuous alteration of the variable is needed, and where cost is not a pressing factor (although he predicted that the day of the 500-dollar computer is not far off). A loop of computer elements were set up directly from a block diagram in a matter of a few minutes.

Dr. D. P. Campbell, Massachusetts Institute of Technology, presented a quick-change method whereby the frequency response and phase-shift character of an entire process loop could be determined. He advocated a change of quality-control measurement from the blendor stage back to the plant stage, which would eliminate the dead time between them, and thereby enable stability to be more easily achieved.

NORTHERN TEXTILE CONFERENCE

Two papers were presented at each of the two sessions of the conference over which V. F. Sepavich, Compton and Knowles Loom Works, presided.

G. W. Knapp, General Electric Company, read the first paper, "Electric Equipment Built Into Textile Machinery." After discussing the problems involved and the advantages of incorporating electric equipment into textile machinery by its manufacturer, the author gave as examples a comber, a cotton card drive, and a heat setting dryer for synthetic fiber fabrics.

"Engineering Safety Into Electric Equipment" was presented by C. F. Hedlund, Associated Factory Mutual Insurance Companies. Statistics covering 1940 to 1949 were given concerning the number of fires and property damage in cotton mills together with data showing the various causes of fires in each process and the number in percentages caused by different classes of electric equipment. The author presented a table classifying the fire hazard of various fibers and processes, which depends on the amount of lint produced in the processing.

R. J. Demartini, F. C. Huyck and Sons, was toastmaster at the Textile Conference luncheon and introduced Robert Browning of Booz, Allen, and Hamilton, whose subject was "Can the Textile Industry Afford Engineers?". In tracing the historical aspects of the textile industry, the speaker brought out

that during the 18th century the spinning and weaving processes were mechanized, but the industry did not continue its technical progress to any great extent—in fact, few fundamental technical changes have occurred in the past 50 years.

The first important indication of a desire by the textile companies to recover a modern engineering position is found in organizational changes within individual companies. Recently a committee submitted a report which recommended a 16-point program which would revitalize the textile industry in New England and three of the points concerned engineers. These points were adjusting work loads, increasing productivity, and reducing power and fuel differentials.

In order to sell management progressive ideas, the engineer must give as much thought to this selling job as he does to the engineering ideas themselves.

The new synthetic fibers have brought new ideas into the textile industry with their new blending and spinning processes, new dyeing and finishing methods, and new or modified weaving and other cloth-making processes which have come into being. All these involve new or modified equipment and operations and these require technical advice—an opportunity for the engineer.

There are other areas which challenge the industrial engineer supported by sound product engineering. The individual textile company may not be able to afford an engineer, but the equipment and material producers' technical staffs are a source of technical knowledge and should not be overlooked. Another source of engineering help is to be found in the independent research institutions and in the research departments of the colleges.

The speaker concluded his remarks with a plea to his listeners that they do everything in their power to persuade the textile industry that it must make greater and more effective use of engineering talent.

The first of the two papers of the afternoon session was "An Integrally Engineered Machine Is Economically Desirable" by R. A. Hudson, Saco-Lowell Shops. He traced the history of textile machinery manufacture for the past 125 years and the gradual incorporation of various mechanical and electrical components into the original design. As an example he explained how a "vacuum cleaner" attachment on a spinning frame was a time-saver in the event of broken ends. The incorporation of this device on existing machines involved many problems but customers demanded it. Now it is built into new model frames as an integral part of the unit. The same sort of integration took place in a lap winder in which a mechanical drive, a mechanical safety device, and a mechanical stop motion were redesigned around an electric motor drive so that all the drives were electric.

In some instances textile mills buy motors and other items from sources other than the manufacturer of the machinery and assemble them into the machine in their own shops. In the event of anything going wrong, the maker of the original machine is held responsible and he must find the trouble. It is logical that the machinery manufacturer should incorporate all the latest devices into his machine and so give the mills an integrated product.

The final paper of the session, "The Value of the Engineer in the Textile Mill," was presented by L. A. Runton, Alexander Smith, Inc. He showed how an engineer can safeguard the mill's profit and loss account by projecting ahead the costs which accrue in a plant in view of the orders taken and the utilization of the equipment. The average cost per kilowatt-hour of power generated by a textile mill is 2.6 cents per kilowatt. In many instances this could be bought on the outside for 1.65 cents, which would mean a substantial saving in the course of a year.

Mr. Runton also gave an analysis of how different machines could be engineered so that their output could be materially increased; this also would mean a saving. The engineer also can effect savings by making a motion study of the most competent workers and then showing others how they can increase their efficiency, and incidentally their pay. In short, the engineer can be a great asset to a mill by applying engineering principles to its problems.

COMMITTEES

Members of the General Advisory Co
mittee for the North Eastern District Me
ing were: F. B. Haeussler, General Cha
man; C. J. Crowdes, Secretary; L.
Cleveland, Historian; W. S. Hill, Vi
Chairman; C. L. Devoe, Treasurer; C.
Powel, Counselor; C. T. Abbott, C.
Maloney, S. M. Osthagen, H. P. Turn
E. W. Boehne, W. F. Potter, L. J. Weed

Chairmen of the other committees
sponsible for arranging the meeting we
E. W. Dillard, Budget and Finance; F.
Snyder, Technical Program; A.
O'Banion, Registration; J. C. Hitt, Ho
Arrangements; L. T. Jester, Publici
W. A. Carlson, 50th Anniversary Banq
and Smoker; J. F. Archibald, Inspecti
Trips and Transportation; Mrs. L.
Weed, Mrs. G. J. Crowdes, Ladies' Ent
tainment; F. S. Bacon, Jr., Hospitali
J. J. Loustaunau, Social Hour; R.
Porter, Students; S. Cowan, AIEE Tex
Subcommittee.

Recent District Meeting Papers Available Upon Request to Authors

A number of authors who presented District papers at recent AIEE District meetings have announced their willingness to supply copies of these papers upon request. (District papers are not scheduled for publication in AIEE *Transactions*.) A list of currently available papers follows. Readers desiring copies should write directly to the respective authors, at the addresses given.

SOUTHERN DISTRICT MEETING

Measuring and Recording Small Voltage Variations Produced by Variable Loads
Rhea W. Baker, Chief Distribution Engineer, Georgia Power Company, P. O. Box 1719, Atlanta 1, Ga.

Electric Power, A Creative Force
Professor C. G. Brennecke, North Carolina State College, Raleigh, N. C.

Operating Experience With Connectors for Aluminum Conductors
(C. E. Bryan, J. H. Exum)
Charles E. Bryan, Chief Engineer, Jackson Electric Department, 119 East College Street, Jackson, Tenn.

Radiotelephone From Wilmington to Shallotte
William C. Burnett, Southern Bell Telephone and Telegraph Company, Box 240, Charlotte 1, N. C.

Neutral Grounding of Industrial Power Systems
Lewis J. Carpenter, General Electric Company, Schenectady, N. Y.

The Influence of Shunt Capacitance Variation Upon the Performance of the Self-Saturating Magnetic Amplifier
Yun Chang, Graduate Training Section, Allis-Chalmers Manufacturing Company, South 70th Street and West Greenfield Avenue, West Allis, Wis.

A Discussion on Methods of Measuring Space Charge
William B. Dodson, American Air Filter Company, 215 Central Avenue, Louisville, Ky.

Design Criteria for Tube Aging and Tube Testing Facilities at Oak Ridge National Laboratory
George A. Holt, Oak Ridge National Laboratory, P. O. Box P, Building 35
Oak Ridge, Tenn.

*Rigorous Calculation of the Capacitance and Ch
acteristic Impedance of Coaxial Transmiss
Lines Composed of Rectangular Tubular Cond
tors*
(T. J. Higgins, S. Hori)
S. Hori, Armour Research Foundati
Technology Center, Chicago 16, Ill.

Fan Cooling of Transformers and Their Econom
(C. R. Jager, W. L. Windham)
Charles R. Jager, Alabama Power Co
pany, 600 North 18th Street, Birmingh
3, Ala.

Education and Training for Living
Claudius Lee, Virginia Polytechnic In
tute, Box 157, Blacksburg, Va.

*A Simplified Method of Field Testing Netw
Protectors*
J. H. Miller, Jr., Alabama Power Co
pany, 68 St. Francis Street, Mobile, A

*Technical Aspects of Electric Equipment Appl
tions in Coal Preparation Plants*
W. R. Morton, General Electric Compa
1 River Road, Schenectady, N. Y.

*Restraining the Repulsive Forces in Large Du
Current-Limiting Reactors*
L. E. Sauer, Westinghouse Electric C
poration, 469 Sharpsville Avenue, Shar
Pa.

*Shape-Correction Factors for Calculating Sh
Circuit Forces of Busses Composed of Dou
Channel Conductors*
(C. M. Siegel, T. J. Higgins)
Clifford M. Siegel, Department of Elec
cal Engineering, University of Virgi
Charlottesville, Va.

*The Determination of Rotor Inductance and
sistance for a Drag-Cup Servomotor*
Dr. William A. Stein, United States Na
Postgraduate School, Electrical Engin
ing Department, Monterey, Calif.

*A Variable-Frequency Drive for Synthetic-Fi
Spinning Machines*
Harry L. Stiltz, 749 Intermont Cir
Hixson, Tenn.

Progress in Current Transformer Design
(F. J. Vogel, D. R. Laib)
F. J. Vogel, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Design of a Dispatching Office
(W. J. Wortman, H. E. Redding)
W. J. Wortman, Duke Power Company, Charlotte, N. C.

Cathodic Control of Corrosion
William T. Zumwalt, Tennessee Valley Authority, 316 Ludlow Avenue, Knoxville, Tenn.

NORTH EASTERN DISTRICT MEETING

Magnetic Amplifiers in Digital Computers
Dudley A. Buck, Massachusetts Institute of Technology Digital Computer Laboratory, 68 Albany Street, Cambridge, Mass.

Automatic Load-Frequency Control Via Power-Line Carrier on the New England Electric System
(L. G. Eaton, R. E. Minkwitz)
L. G. Eaton, New England Power Service Company, 441 Stuart Street, Boston 16, Mass.

A Practical Method for Plotting Electrostatic Field Distribution and Equipotential Lines
(G. E. Jansson, William Harper)
W. E. Harper, Allis-Chalmers Manufacturing Company, 1344 Hyde Park Avenue, Hyde Park 36, Mass.

Engineering Safety Into Electric Equipment
C. F. Hedlund, Factory Mutual Engineering Division, 184 High Street, Boston, Mass.

Equations for the Inductance and Short-Circuit Forces of 3-Phase Busses Comprised of 120-Degree Angles
Professor Thomas J. Higgins, Department of Electrical Engineering, Engineering Building, University of Wisconsin, Madison, Wis.

System Planning for Load Growth
A. A. Johnson, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Electric Equipment Built Into Textile Machinery
G. W. Knapp, General Electric Company, Schenectady, N. Y.

Comparison of Microwave Versus Carrier Channels for Protective Relaying
H. W. Lensner, Westinghouse Electric Corporation, 95 Orange Street, Newark 1, N. J.

Magnetic Amplifier Circuit Techniques
H. Malcolm Ogle, General Electric Company, Building Number 37, 1 River Road, Schenectady 1, N. Y.

The Value of the Engineer in the Textile Mill
Leslie A. Runton, Alexander Smith, Inc., 525 North Broadway, White Plains, N. Y.

Technical and Economic Aspects of High-Voltage Transmission
L. E. Saline, General Electric Company, Schenectady, N. Y.

Bus Voltage Regulation
D. R. Samson, General Electric Company, 1 River Road, Schenectady, N. Y.

A Simple Relay Scheme for Unit Generator-Transformer Station
George Steeb, Niagara-Mohawk Power Corporation, Electric Building, Buffalo 3, N. Y.

Unusual Problems in Construction of Electric Power Crossings
(H. W. Furlong, L. O. Waite)
L. O. Waite, Stone and Webster Engineering Corporation, 49 Federal Street, Boston 7, Mass.

APPLIANCE TECHNICAL CONFERENCE

Copies of all papers presented in the sessions of the Appliance Technical Conference can be obtained from J. H. T. Miller, Jr., Cleveland Electric Illuminating Company, 75 Public Square, Cleveland 1, Ohio. Titles and authors of these papers appear in the April issue of *Electrical Engineering*, page 358, with the program for the AIEE Southern District Meeting.

Officers Announced for New Monroe Subsection

H. B. Balfour, division engineer for the Louisiana Power and Light Company, has been elected Chairman of the newly organized Monroe Subsection of the AIEE Shreveport (La.) Section.

D. E. Blivins, Brown Paper Mill, has been elected Secretary-Treasurer and H. M. Rhodes, Consulting Engineer, has been appointed Program and Publicity Chairman. The new Members Committee consists of Percy Lubke (Chairman), Ford, Bacon and Davis Construction Company; D. F. Burkhalter, Collins Electric Company; and R. B. Bailey, Louisiana Power and Light Company.

The industrial growth of Monroe, La., over the past decade has enabled the formation of this Subsection in the Monroe–West Monroe area. The Subsection was organized through the efforts of a group headed by Chairman W. C. Morris, Jr., of the Shreveport Section. Others were Past Chairman Carl Pons; S. M. Sharp of the AIEE Sections Committee; A. M. Randolph, Publicity Committee Chairman; and Past Chairman L. T. Williams.

Fortescue Fellowship Awards Announced for 1953–54

The Charles LeGeyt Fortescue Fellowship Committee of the Institute has awarded fellowships for graduate study in electrical engineering during the academic year 1953–54 to Richard C. Heyser and John M. Tomlinson.

Mr. Heyser, who is from Phoenix, Ariz., is an honor student at the University of Arizona where he will receive his bachelor of science degree in electrical engineering this month. A Student member of the AIEE and an associate member of the Institute of Radio Engineers (IRE), he was elected to Tau Beta Pi, Sigma Pi Sigma, and Pi Mu Epsilon, honor societies. He has presented two papers to the AIEE-IRE Student Branch at Arizona and another paper won first prize in the Pi Mu Epsilon Essay Contest in 1952.

Mr. Heyser will enter the California Institute of Technology this fall to take graduate work in the computer field.

Mr. Tomlinson is working toward his masters degree at Pennsylvania State College under a graduate assistantship at the present time. The fellowship will enable him to

Milwaukee Section Officers

Activities of the AIEE Milwaukee Section are handled by the above engineers: Seated (left to right): C. P. Feldhausen, Junior Past and Finance Chairman; E. J. Limpel, Section Chairman; J. A. Deubel, Section Secretary-Treasurer; F. J. Van Zeeland, Past Section and Nominating Committee Chairman. Standing (left to right): B. G. Wheeler, Transfers Chairman; D. R. Kanitz, Membership Chairman; H. D. Langley, Electronics Vice-Chairman; J. F. Frank, Power Application and Control Chairman; E. R. Lamb, Electronics Chairman; G. Hutchinson, Director; L. C. Wasson, Basic Science Chairman; R. J. Ungrodt, Director and Student Activities Chairman; J. M. Fleissner, Program Chairman; and Alex Paalu, Education Chairman. Not present were: Directors E. A. Dickinson, R. C. Ball, V. J. Egan, N. C. Storck; E. H. Fredrick, Senior Past Chairman; W. J. Cherones, Historical Chairman; E. L. Nicolson, Professional Development Chairman; N. W. Hoffman, Co-ordinating Chairman; W. Kremmel, Electric Machinery Chairman; G. L. Atkinson, Transmission and Distribution Chairman; and H. C. Brem, Publicity Chairman. The Milwaukee Section has a membership of nearly 1,000 which includes two Subsections, the Fox River Valley Subsection, with Chairman D. C. Christinson, and the Racine-Kenosha Subsection with Chairman R. Garrett

complete his masters degree and to start work on his doctorate during the coming academic year.

While at Pennsylvania State, Mr. Tomlinson has been honored by election to Eta Kappa Nu, Tau Beta Pi, Sigma Tau, and Phi Eta Sigma. He is a member of the AIEE-IRE Joint Student Branch, serving as chairman in 1951–52. In 1952 he also served as chairman of the District 2 Student Prize Paper competition. He is presently devoting part of his time to a computer research project at Pennsylvania State College, and has gained additional experience by working during recent summers with Bethlehem Steel Corporation, Bell Telephone Laboratories, and Westinghouse Research Laboratories. His home town is Montoursville, Pa.

The Fortescue Fellowships were established through a trust fund set up by the Westinghouse Electric Corporation in recognition of Mr. Fortescue's valuable contributions to the electric power industry.

Women's Auxiliary Sets Up Scholarship

At the closing meeting of th year, Mrs. H. R. Paxson, Chai man of the Women's Auxiliar to the AIEE Philadelphia Se tion, presents to Dr. C. Chambers, dean of the Moo School of Electrical Engineerin University of Pennsylvania, check for a new scholarsh fund while Philadelphia Sectio Chairman L. R. Gaty looks o The scholarship will be awarde to an electrical engineerin student in the Philadelphia are and will be available in Se tember. Following the present tion, the following officers wer elected for the coming yea Mrs. W. F. Denkhaus, Chairma

Mrs. C. R. Pearce, Vice-Chairman; Mrs. G. B. Schleicher, Recording Secretary; Mr W. F. Henn, Corresponding Secretary; and Mrs. L. R. Gaty, Treasurer

Engineers Joint Council Reports Activities for 1952

The Engineers Joint Council (EJC) Annual Report for 1952, recently issued, summarizes the year's activities, presents the constitution as of December 7, 1952, and includes a list of the standing committees for 1953.

A highlight of the year for EJC was the decision to broaden the scope of the Council and include in its membership all eligible engineering societies who wish to join. In addition to the AIEE, present member societies are the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Chemical Engineers. However, several of the additional societies have indicated their willingness to join, and it is hoped that by expanding the membership of EJC, and by changing its constitution to make it more truly representative of the active work in the member societies, a step toward greater unity of the profession will have been achieved.

One of the most active projects of EJC during the year was the Engineering Manpower Commission which has become recognized as the authority on engineering manpower.

With private financial support, the Commission has been largely responsible for a sharp increase in the number of freshmen enrolled in engineering colleges, and for suggesting changes in laws and procedures for various national defence agencies.

Another important activity was the setting up of an Atomic Energy Panel, for 1953, which will prepare, subject to approval by the Council, ideas for presentation to the Joint Committee on Atomic Energy concerning changes in the Atomic Energy Act of 1946, which may be needed to encourage ventures in the field of atomic energy by privately owned industries. W. L. Cisler has been named chairman of the panel, and B. R. Prentice is the AIEE representati

Anyone specifically interested in furth details of the EJC report may obtain cop from Engineers Joint Council, 29 West 39 Street, New York 18, N. Y.

Columbus Section Awarded Plaque

E. Bischoff (left), president of the Franklin County chapter of the Ohio Society of Professional Engineers, presents a plaque to F. H. Knapp, Chairman, AIEE Columbus (Ohio) Section, for the best display set up in windows and lobbies of downtown buildings in Columbus to depict progress in engineering in conjunction with "National Engineers Week"

District 2 Student Branch Holds Prize Paper Contest

The District 2 (Middle Eastern) Bran Prize Paper Contest was held at Buckn University, Lewisburg, Pa., April 24–2 1953.

First place in the contest went to L. DiPaolo, A. J. Kane, and C. A. Quinn, of Villanova College, for their paper entitl "The Linear Variable Differential Tra former." The paper was presented by M DiPaolo. Second place went to D. Barger, Johns Hopkins University, who wr and presented a paper entitled, "An El tronic Stimulator for Use on the Hum Eye." Third place was won by a pap "Memory Systems in High-Speed Compu ing Machines," written and presented E. G. Halline, Bucknell University.

The first-prize certificates will be p sented at the General Session of the Summ General Meeting in Atlantic City, N. J.

AIEE Lynn Section Elects New Officers

At a recent meeting of the AIEE Ly (Mass.) Section, E. K. Rohr of the Gene Electric Company was elected Chairman serve for the coming year. The past cha man is T. C. Sargent, Sylvania Elect Company.

Other newly elected officers are: J. Macintyre, General Electric Company, Vice-Chairman; S. W. Stawicki, Champi Lamp Company, as Secretary-Treasur and F. O. MacFee, Jr., Sylvania Elect Company, as Assistant Secretary-Treasure

COMMITTEE ACTIVITIES

Editor's Note: This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.

Communication Division

Committee on Wire Communications Systems (*P. G. Edwards, Chairman; H. R. Huntley, Vice-Chairman; L. R. Montfort, Secretary*). The committee sponsored a technical session at the Winter General Meeting in which four papers were given dealing with the new long-haul coaxial cable system. These papers were concerned with the application of the system amplifiers, equalization regulation, and television terminals.

The committee meeting also was held incidental with the Winter General Meeting, and plans were made to sponsor technical sessions at the forthcoming Summer and Pacific General Meetings.

Industry Division

Committee on Mining and Metal Industry (*J. C. Muir, Chairman; W. R. Harris, Vice-Chairman*). The Committee on Mining and Metal Industry during the past year has reorganized its committee structure to expand its activities to include: promotion of technical papers; organization of round-table discussions and conferences; preparation of committee progress reports or special publications; promotion and organization of special technical conferences; sponsorship of work or studies leading to standards.

The committee considers the sponsorship of work or studies leading to standards to be one of the most important activities for AIEE technical committees. The planning group, selected from the committee membership, prepared guides to be used by the chairman of each of the three subcommittees in making assignments to the members of his subcommittee.

General Applications Division

Committee on Domestic and Commercial Applications (*T. H. Cline, Chairman; T. C. Johnson, Vice-Chairman; J. H. T. Miller, Secretary*). The Subcommittee on Space Heating and Heat Pumps for the East Coast sponsored a technical program at the 1953 Winter General Meeting, at which time a progress report was made on the storage of heat as a means of reducing the demand factor and the load on the transmission and distribution system. Other papers were presented showing various phases of the heat pump problem as it related to the distribution system and to its operation and function in the home.

The Subcommittee on Farm Electrification is now actively planning a conference for approximately October on the many applications and problems involved in the use of electricity on the farm. It is believed there is much interest in the application of electricity to the farm and that this conference will develop into a very desirable activity for the committee.

Denver Section Presentation

At the March meeting of the AIEE Denver (Colo.) Section, Chairman R. B. Hubbard presented the Past Chairman Certificate to E. R. Jones. Left to right are: H. F. Gidlund, Vice-Chairman; Mr. Hubbard; Mr. Jones; and A. E. Paige, Secretary-Treasurer

Committee on Marine Transportation (*J. B. Feder, Chairman; W. E. Jacobsen, Vice-Chairman; W. N. Zippler, Secretary*). Since the last meeting, the several subcommittees have reviewed clarifications, changes, and additions to Standard Number *45*.

The Subcommittee on International Electrotechnical Commission (IEC) Standards has been reviewing the first comprehensive draft of a proposed "Code on Electrical Installations on Ships" prepared by Technical Committee *18* of the IEC. Comments thereon are being compiled for possible presentation to the Commission.

Special subcommittees have been consulting with manufacturers of shipboard equipment on standardization of special marine requirements for the equipment.

Power Division

Committee on Insulated Conductors (*C. T. Hatcher, Chairman; R. J. Wiseman, Vice-Chairman; M. H. McGrath, Secretary*). During the current year the past policy of holding two meetings of the committee was continued. A 2-day session was held in New York, N. Y., on November 20 and 21, 1952, and another 2-day session in Pittsburgh, Pa., on April 20 and 21, 1953. The 2-day sessions have been found to be very desirable as they provide sufficient time for the subcommittees to hold their individual meetings and then meet together for over-all reports and discussions.

The sessions at the Fall General Meeting in New Orleans, La., on insulated aluminum were very successful and, as a result of the interest shown in the conference papers which were presented, approval has been obtained for publishing them in a special AIEE publication.

Committee on Carrier Current (*C. W. Boadway, Chairman; S. C. Leyland, Vice-Chairman (East); R. H. Miller, Vice-Chairman (West); B. W. Storer, Secretary*). Considerable thought and effort have been given to the Symposium on Carrier Current and Microwave to be sponsored by the Committee on Carrier Current during the 1953 Pacific General Meeting in Vancouver, Canada. Tentatively, the date has been set for all day Wednesday, September 2.

During the morning a committee report entitled "Application Guide for Carrier Current" will be presented as a basis for discussion on the subject of carrier current. Similarly, in the afternoon, the discussion on microwave will be introduced by the presentation of a committee report on "Installation and Operating Experience With Microwave for Power System Operation." Ample time will be available following each report for a question and answer period, and each session will be presided over by a chairman and group of advisors qualified to give expert advice on the problems presented.

It is hoped that this type of conference will stimulate interest in the use of these important services for power system operation, and that those engaged in all phases of the power field will avail themselves of the opportunity to become more fully acquainted with present techniques and applications and the latest in carrier-current and microwave developments.

Science and Electronics Division

Committee on Nucleonics (*G. W. Dunlap; Chairman; W. E. Barbour, Jr., Vice-Chairman; H. W. Bibber, Secretary*). Few other committees of the AIEE operate under the security difficulties which face the Committee on Nucleonics. It is anxious to co-operate with all government agencies in maintaining proper security restrictions, but attempts to make available to interested AIEE members details of nuclear developments related to electrical engineering as rapidly as they are declassified.

Attendance at sessions it has sponsored, as well as correspondence, has indicated the major interests of AIEE members now as: (1) reactor operation and control, (2) nucleonic instruments, and (3) radioactive tracers in studies of materials used in equipment. Much of the subject matter in item 1 is related to feedback control systems, and in item 2 is related to instruments and measurements, so that joint activities with these as well as many other committees in the AIEE have represented a large part of its activities. Examples of such activities include participation with the Committee on Electrical

St. Lawrence International Subsection

On April 15, 1953, the St. Lawrence International Subsection of the AIEE Syracuse (N. Y.) Section met in Potsdam, N. Y. Seated at the main table are shown, left to right, Past Chairman N. O. Ross and Mrs. Ross; Subsection Chairman L. F. Pries and Mrs. Pries; M. S. Paige, speaker for the evening; J. J. Hays, who introduced the speaker; Past Chairman P. F. Mengel and Mrs. Mengel; and Dr. A. R. Powers, who played a large part in the founding of the Subsection

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Techniques in Medicine and Biology, in holding a conference in New York in November each year on "Electronic Instrumentation and Nucleonics in Medicine"; talks by leaders in the field at the general session of the 1953 North Eastern District Meeting on atomic power, and on nuclear research in retrospect and in prospect; and a joint session with the Committee on Power Generation at the Summer General Meeting in June 1953 on the subject of atomic power development.

AIEE FELLOWS ELECTED..

Board of Directors Meeting, January 22, 1953

Joseph W. Allen (M '41), senior electrical engineer, Eclipse Pioneer Division, Bendix Aviation Corporation, Teterboro, N. J., has been transferred to the grade of Fellow in the AIEE "for pioneering and outstanding achievement in the development of electric systems and equipment for aircraft." Mr. Allen was born in Carbondale, Pa., March 12, 1893, and graduated from Bucknell University in 1915 with a bachelor of science degree in electrical engineering. Upon completing the test course at the General Electric Company, Schenectady, N. Y., he was assigned to the synchronous converter department. While there he enlisted in the Signal Corps during World War I, and after a flight training course received his commission and qualified as a pilot. After World War I he accepted a position at McCook Field (now Air Material Center), Dayton, Ohio, in connection with the development of air-borne electric equipment. This work included development, test, and approval of generators, generator controls, starters, storage batteries, ignition and power cable, switches, interior and exterior lighting. The work stressed reduction of weight and size. By 1926 Mr. Allen had been placed in charge of all work of the electrical branch. In 1928 he accepted a position with Eclipse, a division of Bendix Aviation, and was advanced to chief electrical engineer prior to 1940. In 1942 he joined the Bureau of Aeronautics where he was placed in charge of development, application, and approval of rotating machinery for use in Naval aircraft. He returned to Eclipse-Pioneer Division of Bendix as senior engineer in charge of development of aircraft electrical accessories, which includes a-c and d-c generators, motor-generator units, motors, generators, control units, and fault protective systems. Mr. Allen has received over 40 patents and has evidenced originality also in the design of electric machines and equipment for aircraft where high densities of current in both brushes and copper as well as iron were proved to be practicable beyond the accepted recommended ranges because the heat rejection in a small unit was possible and advisable in reducing size and weight. He conceived, projected, and built the first a-c system installed in an aircraft as such. During the entire war period, 1941–46, generators for aircraft were procured and applied without formal specifications based on his experience and judgment with only laboratory tests as a guide. Mr. Allen has been continually and intimately concerned with and active in the engineering and development phase of electric power for aircraft since 1920. He is a member of the Institute of the Aeronautical Sciences and the Society of Automotive Engineers and has served on the AIEE Committees on Air Transportation (1944–53) and Standards (1946–53).

Andre G. Clavier (M'48), technical assistant to president, Federal Telecommunication Laboratories, Inc., Nutley, N. J., has been transferred to the grade of Fellow in the AIEE "for pioneer work in research, development, and engineering in communication in the microwave field." Mr. Clavier was born in Cambrai, France, February 15, 1894, and received an ingenieur diplomé de l'Éc Superieure d'Electricité in 1920 from Sorbonne, Paris, France. From 1920 to 19 he was department head, French Sig Corps Laboratories, Paris, where he work on short-wave developments and the desi of advanced military radio equipment. was division head, Société Française Rad électrique, Paris, from 1925 to 1927 worki on design of short-wave transmitters of sp cial types. In 1929 he joined Laborato Central de Telecommunications, an affili of International Telephone and Telegra Company, Paris, as a division head. In 19 he designed and supervised a microwave li on 1,700 megacycles over the English Cha nel. He did other work on microwave lin in England and France and conduct propagation studies of fading on microwa links. He also conducted research on pc tive grid tubes and waveguide magnetro He became assistant research director at t laboratories in 1944. From 1942 to 1946 also was a professor of electromagnetic fie theory at École Superieure d'Electric Malakoff, Seine, teaching a course for po graduate students. He came to the Unit States in 1946, joining Federal Telecommu cation Laboratories as assistant technic director. In 1949 he became technical assi ant to the president, handling special techn cal and administrative assignments. M Clavier is a member of the Société França des Electriciens and the Société des Radi électriciens, France, the Institution of Ele trical Engineers, Great Britain, and a fell of the Institute of Radio Engineers. He h served on the AIEE Committee on Spec Communications Applications (1951–52).

Albert A. Nims (AM '11, M '28), electric engineering department, Union Colleg Schenectady, N. Y., has been transferred the grade of Fellow in the AIEE "for ou standing contributions to the electric engineering profession in the theory a design of arc-welding equipments, armatu windings of electric machines, and in electr network analysis. Also, outstanding cont butions to engineering education." M Nims was born in Montague, Mass., Augu 1, 1886, and graduated from Worcest Polytechnic Institute in 1908 with a bachel of science degree in electrical engineerin He received the electrical engineering degr from the same institution in 1911. M Nims was design engineer for the Crock Wheeler Company, Ampere, N. J., fr 1912 to 1919, specializing in d-c machin He was engineer-in-charge of design a construction for the Siemund Wen Electric Welding Company, New Yo N. Y., from 1919 to 1922, specializing electric arc-welding equipment. In 19 he began his teaching career as part-ti assistant instructor at Worcester (Mas Polytechnic Institute; in 1917 he resum his teaching of engineering as night sch instructor at The Cooper Union, New Yo N. Y. In 1918 he began, as an eveni instructor, his long engineering-teachi career at Newark Technical School a Newark (N. J.) College of Engineeri In 1922 he left industry for full-time teachi at Newark College of Engineering. He w made chairman of the electrical engineeri department, a post which he held until retirement in 1952. Mr. Nims joined staff of the department of electrical engine

Joseph W. Allen

Andre G. Clavier

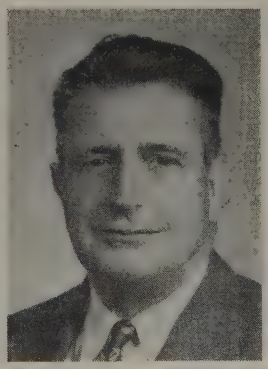
Albert A. Nims

; at Union College early in 1953. Mr. ms has designed and developed one of e first single-operator arc-type welding nerators with inherent regulation; he signed a new multiple-wave armature nding with the commutating charac-istics of the simplex lap winding and the x averaging characteristics of the simplex ve winding. He applied the Potier angle techniques to the predetermination the regulation characteristics of d-c ma-ines of all types; he developed a general oretical approach to the subject of arma-e windings, embodied in a monograph ich was used as the text for a course in subject, and he originated material in vanced network analysis concerned prin-ally with resonant coupled circuits. r. Nims initiated pioneering groundwork electrical engineering subjects which stitute the separate courses in networks, ctronics, and electric circuit transients, d organized the electrical engineering riculum along the lines of electric circuits, ctronics, and electric machines. Mr. ms is a member of the American Society Engineering Education, Tau Beta Pi, d Sigma Xi.

inot H. Pratt (M '34), division engineer, agara Mohawk Power Corporation, West racuse, N. Y., has been transferred to the ade of Fellow in the AIEE "for outstanding ntributions in the development of im-oved methods and equipment essential to efficient operation of a major electric dis-bution system." Mr. Pratt was born July 1903, in Providence, R. I., and graduated m the University of Pennsylvania in 1926 h a bachelor of science degree in mechani-engineering. Following his graduation he s selected by the United Gas Improvement ganization as a cadet engineer assigned to Syracuse (N. Y.) Lighting Company as per in the underground cable department. bsequently he was placed in charge of a nstruction crew working on new cable nholes and duct lines. The next year he s made engineering assistant to the electri-distribution engineer. He prepared an ginal study based on field investigations d discussions with others on "Cedar versus ie Poles for Distribution Lines." In Oc-ber 1927 Mr. Pratt was made assistant tribution engineer with full charge and ponsibility for supervision of all new line out work of all voltages, load testing, radio erference, construction progress, and the tribution and transmission system maps d records. Mr. Pratt became assistant to the executive responsible for engineering, operation, and construction of electrical facilities in 1928. He investigated work methods which led to the development of a trailer-type tool box to replace the heavy trunk-type containers used by underground cable splicing crews and also studied and designed a sectional-type manhole form for building concrete manholes. He became engineer of the electric department in 1929 with sole responsibility to management for engineering, operation, construction, and maintenance of electrical properties. In 1931 he became assistant division engineer for the Central Division, Niagara Hudson Power Corporation, and in 1932 he was named division electrical engineer. His duties were the direct supervision of the electrical section's engineering and design work. During these years, Mr. Pratt was active in the use of high-impulse insulation designs for intermediate-voltage transmission lines and in the study of various lightning protective designs for such lines. In 1946 Mr. Pratt was made chief engineer for Central New York Power Corporation (a consolidation of former Niagara Hudson divisions) in full charge of the planning and design of the electric and gas facilities and systems; special studies and research relating to economics, depreciation, load flows; the establishment of construction standards for overhead and underground lines and substations, including gas transmission and distribution; the development of engineering property records; construction budgets; technical specifications for contracts, materials; and inspection and approval of all construction. In January 1950 the major operating companies of the Niagara Hudson System were consolidated into a single operating company, Niagara Mohawk Power Corporation, Mr. Pratt becoming division engineer. He is a member of Tau Beta Pi, Sigma Xi, and the National Society of Professional Engineers, and has served on the AIEE Committee on Transformers (1947–53).

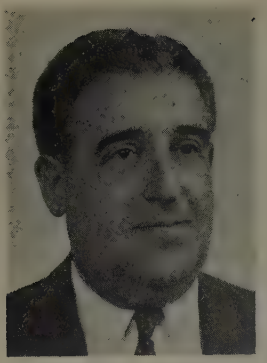
George B. Scheer (AM '37, M '40), chief consulting electrical engineer, Kaiser Engineers Division, Henry J. Kaiser Company, Oakland, Calif., has been transferred to the grade of Fellow in the AIEE "for outstanding achievements, ingenuity, and broad engineering ability in designing power supply and electric equipment layout for aluminum reduction plants and steel mills, including a number of electrical applications new to the industry." Mr. Scheer was born in San Francisco, Calif., April 2, 1898, and graduated from the University of California in 1920 with a bachelor of science degree in electrical engineering. He then attended the Westinghouse Electric and Manufacturing Company's (now Westinghouse Electric Corporation) engineering school and in 1921 became a design engineer in that firm's East Pittsburgh, Pa., plant. From 1922 to 1936 Mr. Scheer was engaged in engineering and contracting work in San Francisco, being employed by several municipalities on proposed and actual municipal ownerships of electrical utilities. In 1936 he became a senior electrical engineer for the State of California on the designing of electrical facilities on the San Francisco–Oakland Bay Bridge. This work involved a double-track interurban railway system with overhead and third-rail power lines and an automatic signal control. He also was charged with the studies of electrolysis problems on the bridge. Upon completion of the bridge in 1939 he returned to the consulting profession and as a consultant for various Kaiser industries was responsible for the electrical work at Permanente Cement, the 11-mile conveyor at Shasta Dam, the carbothermic magnesium plant at Permanente, and the steel plant at Fontana. He was in charge of complete design of all electric power facilities for Permanente Metals Corporation's Magnesium Plant, Permanente, Calif. (approximately 60,000-kva main substation capacity) together with design of two associated plants at Natividad, Calif. (approximately 2,000-horsepower connected load) and Magnesium Seawater Plant, Moss Landing, Calif. From 1942 to 1944 he was in charge of design of complete electric power facilities for fully integrated iron and steel plant at Fontana, Calif., having an installed capacity of ap-

Minot H. Pratt



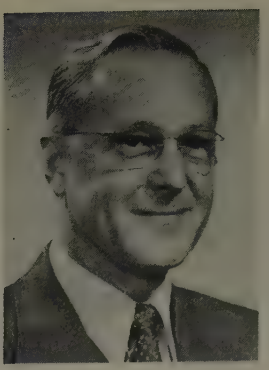
George B. Scheer

Kilburn M. Smith



Dimitri Trone

William W. Wishard



John C. Woods

proximately 40,000 kva. Facilities provided for were blast furnace, coke plant, boiler plant, plate mill, structural mill, merchant mill, and related auxiliaries. Mr. Scheer also was in charge of design for Shell Manufacturing Plant, Fontana and Denver, Colo., with a total capacity of approximately 40,000 horsepower. In 1946, when Kaiser Engineers was organized as an engineering company, he became their chief consulting electrical engineer and since that time, in addition to the over-all electrical responsibility, has had charge of the electrical development of the steel plant at Fontana, the electrical work in the aluminum reduction plants, and has been in charge of all phases of a 473,000-kw powerhouse for an aluminum plant at New Orleans, La. Mr. Scheer is a member of the Engineers Club of San Francisco, the Electrochemical Society, and the Association of Iron and Steel Engineers. He has served on the AIEE Committees on Electrochemical and Electrothermal Applications (1947–53) and Electronic Power Converters (1952–53).

Kilburn M. Smith (AM '25, M '33), system planning engineer, Engineering Department, Commonwealth Edison Company, Chicago, Ill., has been transferred to the grade of Fellow in the AIEE "for contributions to the field of power system engineering, particularly in the pioneering of high-voltage transmission of bulk power in densely loaded areas." Mr. Smith was born in Hingham, Mass., May 18, 1902, and graduated from Massachusetts Institute of Technology in 1923 with a bachelor of science degree in electrical engineering. He entered the Engineering Department of Commonwealth Edison the same year. His first assignment was in the design of the 4,000-volt distribution system. When the low-voltage a-c network system of distribution was introduced in Chicago in 1933, Mr. Smith was placed in charge of planning the development of this system. In 1937 he was made a supervising planning engineer, and in 1943 he was appointed assistant system planning engineer. In 1949 he was named to his present position. In his capacity as planning engineer, Mr. Smith has had the major responsibility for the development and growth of the a-c network system in Chicago. Since the start of the system in 1936, the system supplying the downtown and immediately adjoining areas of the city has grown to a total of over 200,000 kva. Mr. Smith pioneered the use of 480-volt spot networks in large buildings, a move which has been quite successful in Chicago. He also has been active in the development of the transmission and general distribution system in the Chicago area. He has co-operated in the initiation of the use of 66,000 volts for subtransmission in the area. This system has been expanded to supply five substations with a total load of about 250,000 kva, with other similar installations authorized but not yet in service. Mr. Smith's responsibilities have included planning adequate electrical capacity of all system units from generating stations to circuit feeders, for system relay protection, and for the application of new engineering ideas to the system where economy of design or quality of service could be improved. He now has the major responsibility for all system planning activities for a system with a load of approximately 3,000,000 kw. Mr. Smith is a member of the Western Society of Engineers and has served on the AIEE Committee on Transmission and Distribution (1948–50).

Dimitri Trone (AM '24, M '30), chief engineer, General Electric S. A., Rio de Janeiro, Brazil, has been transferred to the grade of Fellow in the AIEE "for pioneering activities in electric power generation on the electrification of transportation system in foreign fields, particularly in Russia and Brazil." Mr. Trone was born in Riga, Latvia, September 14, 1901, and received his bachelor of science degree in electrical engineering from Union College in 1923 and his masters degree in 1924. After doing advanced work at Massachusetts Institute of Technology, Mr. Trone joined the General Electric Company in 1925. Upon completion of the company's test course he was assigned to the Large Power Transformer Design Department, Pittsfield, Mass., and the next year was transferred to the Central Station Engineering Department, Schenectady, N. Y. There he participated in work on selection and application of electric equipment for hydroelectric and steam-turbine electric power stations, step-up and step-down substations; short-circuit studies and relay application studies; and others. In January 1929 he was transferred to the Alabama Power Company, Birmingham, under an engineering exchange agreement. While here he worked on studies for new power stations, substations, and transmission lines. In July 1929 he was called back to Schenectady and assigned to take part in preparation of engineering studies and specifications for a 3,000-volt d-c electrification of the Trans-Caucasian Railway, Russia. In November 1929 he was assigned to the engineer office in Moscow, Russia, and was clos associated with the construction of Dnieprostroy Hydroelectric Power Stat in the Ukraine and the electrification of Trans-Caucasian Railway. During his s in Russia, he was responsible for cen station, industrial, and railway engineer application, and consultations related to In 1934 he returned to New York with International General Electric Compa where he worked on application engineer and equipment selection for proposals re tive to export. This included equipment central stations, substations, and transm sion lines. In January 1942 the Brazil government sent an engineering mission the United States to engage a consult engineering firm and purchase machine equipment, and materials for the constr tion of a large, modern steel mill at Vo Redonda, Brazil. Mr. Trone was loaned the steel company to prepare complete a final detailed electric installation layout a power distribution drawings and to prep complete bills of materials. In August 19 he returned to General Electric from Br to report on the engineering work done, a in November of that year returned to R de Janeiro to join the staff of General Elec S. A. permanently as technical assista During a 5-year period, Mr. Trone was sponsible for all application engineering the electric apparatus field. Some of projects at this time were a study for solution of a voltage regulation problem the power supply system of the largest elec fied railway of Brazil; supervision of construction of the first television transmi and studio installation of Rio de Janei and installation of large a-c to d-c conv sion equipment at the power station in of Brazil's northern ports. In January 19 Mr. Trone was appointed chief engineer General Electric S. A. With this appo ment, his former duties continued with additional duties of engineering responsibi in work of the electronics department, lig ing department, service department, merchandizing department. Mr. Trone member of Sigma Xi, Association of Iron Steel Engineers, Society of American Milit Engineers, and Brazilian Technical Sta ards Association.

William W. Wishard (AM '26, M '40), e trical engineer, Commonwealth Edison Co pany, Chicago, Ill., has been transferred the grade of Fellow in the AIEE "for o standing contributions and originality in application of high-voltage subtransmiss systems to high-density load areas, and sound engineering judgment and able lead ship of an engineering organization of a la utility system." Mr. Wishard was born Bloomfield, Iowa, September 10, 1893, graduated from Iowa State College in 1 with a bachelor of science degree in electr engineering. After spending a year with San Joaquin Light and Power Compa Fresno, Calif., he entered the engineer department of Commonwealth Edison C pany in 1920. In 1924 he was made assis chief draftsman. After leaving the draf division in 1927, he was a field engineer f years and a supervising field engineer fo additional 5 years. During this period a tem of industrial substations on the cust er's premises supplied by 12,000-volt

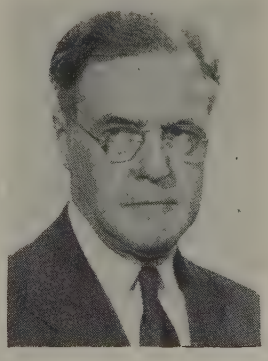
eders from generating stations and distribu-
on centers was initiated and developed by
r. Wishard. He also supervised construc-
on of the initial low-voltage a-c network
stem for the supply of the high-density area
downtown Chicago. Original design
atures incorporated in the network system
ere unique supports for long vertical cables;
ansformer manhole designs to provide ade-
uate ventilation; and safety features and a
pervisory control system for monitoring
e transformer loads at a common dis-
atching office. In 1937 Mr. Wishard was
aced in charge of a section of the Engineer-
g Department, responsible for the issuance
orders for and engineering supervision of
ectric installations in generating and dis-
ibuting stations, transmission terminals,
bstations, industrial substations, network
aults, and transformer vaults. From 1943
ntil 1950, Mr. Wishard was station design
ngineer, in charge of a division of the engi-
eering department responsible for general
signs, installation specifications, and engi-
eering supervision of all electric plant facili-
es, and for structural and mechanical plant
assigned, in generating and distributing
ations, transmission terminals, substations,
dustrial substations, network vaults, and
ansformer vaults. During this period of
evelopment, 555,000 kw of new generation
ere added to the system which included a
ew generating station of 300,000 kw initial
apacity incorporating a completely central-
ed electronic combustion control system.
n May 1950 he became assistant chief elec-
ical engineer. During this period he de-
loped a new subtransmission system to
pply the fast growing load of the company.
istributing stations in remote load centers
ere built and supplied by 69-kv subtrans-
ission lines. He became electrical engineer
1952 responsible for supervision and ad-
inistration of transmission, distribution,
neerating, system planning, and drafting
visions of the engineering department.
Ir. Wishard is a member of the Western
ociety of Engineers and has served on the
IEE Committee on Rotating Machinery
949–52).

ohn C. Woods (AM '23, M '31), station
esign engineer, Commonwealth Edison
ompany, Chicago, Ill., has been transferred
the grade of Fellow in the AIEE "for
ntributions in the field of electrical control
large turbogenerators and improvements
substation design contributing to their
liability and economy." Mr. Woods was
rn in Grayson, Ky., October 26, 1896, and
tended Westinghouse Technical School and
rmour Institute of Technology. In May
24, he started with the Commonwealth
dison Company as a draftsman, and in 1926
as put in charge of the drafting section con-
rned with d-c substations. In 1929 he was
ade electrical designer with responsibility
r the physical design of all d-c substations
the company, including selection of equip-
ent. Incorporated in the design of these
bstations were several original features
hich included a 1-way relay contact for
gnal purposes and a circuit for determina-
on of current unbalance due to circuit
eaker contact resistance. From 1936 to
40, as design engineer, he was responsible
r making engineering studies of system
tensions and maintenance, basic design
specific projects, equipment selection, cost
estimates, and general supervision of the preparation of drawings and approval of drawings for substations. In 1940 he became supervising design engineer, directing the work of a group of design engineers preparing electrical plans and specifications for all new generating stations and distributing stations and for additions to existing stations on the company's system. Three outstanding examples of important basic engineering designs developed by Mr. Woods during this period were a large isolated-phase 15-kv switchhouse and 69-kv outdoor terminal in which great efficiency in space utilization and considerable improvement for safety and operation were incorporated; the use of prefabricated unit-type relay switchboard panel; and the use of standard basic elements for training cable in trays. From 1943 to 1944 Mr. Woods was on leave of absence from the Edison Company and assigned a position with Sargent and Lundy as an electrical designer and installation supervisor of the construction of a large steam generating station for the Manhattan District of the Atomic Energy Project, Oak Ridge, Tenn. The design of this plant required the installation of a large number of independently operated turbogenerators with strict requirements for unusually accurate frequency control and for instantaneous automatic transfer of reserve generators to replace any unit in trouble. Resuming his position as supervising design engineer in the station design division between 1944 and 1950 he was in charge of the electrical design for all generating and distributing stations. Mr. Woods developed original designs for a compact and flexible means of supporting cables in vertical shafts and a grid-controlled thyratron rectifier for governor operation. In 1950 he became station design engineer, supervising and co-ordinating the structural, mechanical, and electrical designs of generating, distributing stations and substations. Mr. Woods has been responsible for the development of a new outdoor-type substation and further improvements in the basic design of large turbogenerator installations. Mr. Woods has served on the Institute Committees on Switchgear (1947–53) and Membership (1946–53, Chairman 1950–52).

AIEE PERSONALITIES.....

F. M. Farmer (AM '02, F '13, Member for Life), president, Electrical Testing Laboratories, New York, N. Y., has retired after nearly 50 years continuous service with the company. He continues on the board of directors of which he has been elected honorary chairman. He has been president since 1949, having served previously as chief engineer and vice-president of the laboratories. An 1899 mechanical engineering graduate of Cornell University, he worked in the Testing Department of the General Electric Company, Schenectady, N. Y., for 18 months after his graduation. During the years 1902–06, he was an instructor in electrical measurements and physics in the Night School of Science, Cooper Union Institute, New York, N. Y. He has been associated with Electrical Testing Laboratories since 1903. Mr. Farmer has been extremely active in engineering organizations. He is a member of the American Association for the Advancement of Science and The American Society of Mechanical Engineers. He is a past president of the AIEE (1939–40), the American Society for Testing Materials, the American Welding Society, and the United Engineering Trustees. He has been chairman of the Engineering Foundation and the American Standards Association Standards Council. Mr. Farmer served as a director of the Institute (1934–38) and vice-president (1938–39). Some of the committees on which he has served are Standards; Board of Examiners; Transmission and Distribution; Electric Welding; Research; Technical Program; Award of Institute Prizes; Executive; Edison Medal; Finance; Planning and Co-ordination; Publication; and Constitution and Bylaws.

J. D. Tebo (AM '36, F '51), associate editor, Bell Telephone Laboratories, New York, N. Y., has been appointed editor of the *Bell System Technical Journal* and of the *Bell Laboratories Record*. Born July 5, 1903, in Harpers Ferry, W. Va., Dr. Tebo received the degrees of bachelor of engineering in 1924 and doctor of engineering in 1928 from Johns Hopkins University. In 1924 and 1925 he took the student training course in meter and relay operating at the Westinghouse Electric Corporation, East Pittsburgh, Pa. His asso-



F. M. Farmer

J. D. Tebo

ciation with Bell Telephone Laboratories began in 1928, at which time he was engaged in electromagnetic design. In 1938 he was put in charge of the machine switching laboratory. During World War II he was concerned with the development and manufacture of radar and sonar equipment for use by the Armed Forces. Following the war he returned to machine switching and in 1949 became science editor of the *Bell Laboratories Record*. Active in the affairs of the Institute, Dr. Tebo was chairman of the New York Section (1950–51); chairman of the Committee on Basic Sciences (1946–48); Science and Electronics Co-ordinating Committee (1948–49), and Science and Electronics Division Committee (1949–50). He is presently a member of the Publication Committee and Vice-Chairman of the Committee on Technical Operations. Mr. Tebo is a member of Sigma Xi.

OBITUARY

Gano Dunn (AM '91, M '94, F '12, HM '45, Member for Life), president, J. G. White Engineering Corporation, New York, N. Y., and a former president of the AIEE, died April 10, 1953. Dr. Dunn was born in New York, N. Y., October 18, 1870. He received a bachelor of science degree from the College of the City of New York in 1889 and 2 years later had the distinction of receiving from Columbia University the first degree in electrical engineering awarded in the United States. After several years in the communications and electrical engineering field, Dr. Dunn joined J. G. White Engineering Corportation, New York, N. Y., in 1911 as vice-president in charge of engineering and construction. Two years later he was elected to the presidency of the company and the corporation became one of the most prominent construction firms in the world. Among the projects constructed were the United States Naval Oil Base at Pearl Harbor, the steam plant at Muscle Shoals, Ala., 13 transoceanic radio stations, the original Government aviation station at Langley Field, Va., and the first long-distance natural gas pipe line in California, as well as completing programs of roads, oil, and irrigation in Latin America. Dr. Dunn was elected to the board of directors of the Radio Corporation of America in 1938. He was chairman of trustees and former president of Cooper Union for Advancement of Science and Art. He was a trustee of Barnard College and a member of the visiting committee of Harvard Engineering School. He was a member of the late President Roosevelt's Science Advisory Board. Among the many awards presented to Dr. Dunn were the Townsend Harris Medal of the College of the City of New York, the Thomas A. Edison Medal of the AIEE (1937), the Egleston Medal of Columbia University, the Hoover Medal of the National Engineering Societies (1939), Modern Pioneer Award of the National Association of Manufacturers, and the Peter Cooper Medal of the Cooper Union. Dr. Dunn received honorary degrees of doctor of science from Columbia University, Rutgers University, and New York University. In 1947, Bowdoin College presented Dr. Dunn with a doctor of laws degree. Dr. Dunn was a fellow of the Institute of Radio Engineers, the Royal Microscopy Society, and the New York Academy of Sciences. He was honorary secretary for the United States of the Institution of Electrical Engineers of Great Britain, a member of the American Society of Civil Engineers, The American Society of Mechanical Engineers, Optical Society of America, American Academy of Arts and Sciences, American Philosophical Society, and others. He was also a member of Phi Beta Kappa and Sigma Xi. An exceptionally active member

Gano Dunn

of the AIEE, Dr. Dunn had served as president (1911–12), vice-president (1900–02, 1905–07), and manager (1897–1900, 1902–05), and on the following Institute committees: Code of Principles of Professional Conduct (1914–19); Iron and Steel Industry (1914–16); Public Policy (1914–17, 1920–30, Chairman 1925–27); Edison Medal (1922–27, 1932–37, Chairman 1924–27); Education (1925–26); Hoover Medal Board of Award (1931–39); and many other committees in co-operation with other engineering societies. The Council of the Institution of Electrical Engineers, through its secretary, Mr. V. K. Brasher, has expressed its deep regret on the passing of Dr. Dunn in the following letter from Mr. Brasher to Mr. R. H. Barclay of the J. G. White Engineering Corporation: "He was, of course, known personally to several members of the Council and those who had not had the privilege of meeting him knew of his outstanding work not only for The Institution but also in the cause of Anglo-American friendship. He was known to many members of The Institution, a substantial number of whom have reason to be thankful to him for the advice and help he so readily gave them when, strangers as they were in a new country, they turned to him for guidance. The Council feels that it would be difficult to find anyone with qualities so ideally suited to the Office which he held and that his passing leaves a gap which it will be difficult for them to fill. They would appreciate it greatly if you would be so kind as to convey a meassage of their deep sympathy to Gano Dunn's next-of-kin and also, if you think fit, to his many business associates and friends in the AIEE."

Per Engelbert Erikson (M '24, F '28), retired, Malmo, Sweden, died December 7, 1952. Mr. Erikson was born in Malmo, September 28, 1880, and received the degr of electrical engineer from the Royal Ins tute of Technology, Stockholm, in 1903. then joined the Western Electric Compar New York, N. Y., to do developmental wo on loading coils and balanced toll cabl He was transferred to London, England, 1909 as European transmission engine He had charge of the systems planning of t first loaded long-distance cable installed Europe, which linked London and Birmin ham, England. In 1916 he returned to N York City to continue with transmissi studies and design work. During 1918 supervised the reconstruction of the te phone transmission line between Rio Janeiro and São Paulo, Brazil, the first Brazil to be equipped with repeaters a and loaded toll entrance cables. Mr. Er son returned to London in 1919 to what w then the International Western Elect Company and was to become the Int national Standard Electric Corporation 1925. In 1928 he became assistant vi president in charge of the technical divisi of the European commercial departme From 1930 to 1932 he was European ch engineer. In 1940 Mr. Erikson was tra ferred to Sweden as liaison officer betwe New York and affiliated companies Scandinavia. He returned to London 1946 as technical advisor to the Europe commercial department. From 1938 to retirement in 1950, Mr. Erikson served a director of A. B. Standard Radiofabrik Stockholm. Starting in 1924 he was act in the International Consultative Commit on Telephony. Since 1929 he served a delegate for the operating companies, coming secretary in 1934. He was a me ber of the Institution of Electrical Engine Great Britain, and the Svenska Teknol föreningen.

Harry Lepper Kirker (AM '03, M F '13, Member for Life), retired, died Ap 2, 1953. Mr. Kirker was born in Catle burg, Ky., March 4, 1866, and gradua from Ohio State University in 1889 wit bachelor of science degree. He joi Westinghouse Electric and Manufactur Company (now Westinghouse Electric C poration) in Pittsburgh, Pa., in 1890, a was retired on reaching the company's limit in 1931. During this period he a worked for the Bed Rock Dredging Corpo tion, Boise Basin, Idaho, and the Fren British, and Norwegian Westinghouse co panies. His work was largely in the fi and pertained to railway electrifications a power plants. At the factory he worked w the testing department and student cou and later with projects and reports. He resident engineer for the British Westi house Company on the London Metropoli Railway electrification and the Mer Tunnel Railway electrification at Liverpo He was also resident engineer for the Gra Trunk Railway St. Clair Tunnel electrifi tion at Port Huron, Mich., and Sarn Ontario, Canada. He was a member of Engineers Society of Western Pennsylva the American Transit Association, American Association for the Advancem of Science, and many pomological societi

Royce Allen Beekman (AM '13, M F '49, Member for Life) retired, died A 1, 1953. Mr. Beekman was born in

uis, Mo., July 19, 1888, and was gradu-d from the University of Missouri in 1910 th a degree of bachelor of science in elec-cal engineering. He had been employed the General Electric Company for 42 ars when he retired on August 1, 1952. the time of his retirement he was manager the federal and marine engineering divi-n. Mr. Beekman entered the General ectric Company's student test course in ly 1910 and transferred to the Marine gineering Department in February 1912. r most of his career, Mr. Beekman was ociated with marine activities and held a mber of patents relating to electric ship opulsion. He was active in the applica-n and installation of electric propelling achinery on the *Lexington*, *Saratoga*, and ner United States Naval vessels. He was nember of Tau Beta Pi and the Society of aval Architects and Marine Engineers. r. Beekman had served on the following EE committees: Application to Marine ork, Marine Transportation (1919–50, airman 1930–33); Standards (1939–41, 42–48); and Technical Program (1930–).

rl Edward Johnson (AM '09, M '19, '25, Member for Life), chairman of the ard, Sterling Electric Motors, Inc., Los ngeles, Calif., died March 26, 1953. Mr. hnson was born in Chicago, Ill., October 1883, and moved to San Francisco, Calif., 1903. Two years later he moved to Los ngeles where he was in charge of redesign-g and rebuilding electric machinery for oodill and Hulse Electric Company. In 06 he organized the Dynamo Electric achine Company and engaged in the anufacture of electric motors. In 1908 he ganized the U. S. Electrical Manufacturing mpany which absorbed the Dynamo ectrical Machine Company. From 1906 1927 Mr. Johnson made many major chnical contributions to the electric motor ld, being directly responsible for approxi-ately 30 patents. In 1927 he founded erling Electric Motors, Inc., and added patents on electric apparatus to his list inventions. He recently had received a -year certificate from the National Elec-cal Manufacturers Association in recog-tion of his services to the electrical industry. r. Johnson had been a member of the EE Committee on Electrical Machinery 938–39, 1940–41).

chard Edmund Brown (AM '17, M '34, ember for Life) retired, died March 26, 53. Mr. Brown was born in Friedens-rg, Pa., October 18, 1886, and received bachelors degree in electrical engineering m Lehigh University in 1910 and his asters from Cornell University in 1916. om 1911–1912 he was employed by the estinghouse Electric and Manufacturing mpany (now Westinghouse Electric Cor-ration). He was an instructor in physics d mathematics at Bryant and Stratton llege, Buffalo, N. Y., from 1913 to 1915. became an instructor in electrical engi-ering at the University of Pennsylvania in 17, becoming an assistant professor in 22. In 1929 he joined New York Univer-y, New York, as associate professor of elec-cal engineering, becoming acting head of the department of electrical engineering in 1932, and head of the department in 1935. He retired in 1939. He was a member of the American Association for the Advancement of Science and had served on the AIEE Committee on Electrical Machinery (1921–24).

Bernard Waldo Wallace (AM '47, M '52), regulation engineer, Toledo (Ohio) Edison Company, died April 18, 1953. Mr. Wallace was born at Fairmount, Ill., July 27, 1900, and graduated from Purdue University with a bachelor of science degree in mechanical engineering in 1923. Following his graduation he joined the Toledo Edison Company as a junior engineer. Upon completion of his training course, he was assigned to the results engineering department in 1924. In 1927 he was transferred to the distribution engineering department. In 1928 he was sent to Long Branch, Mich., to take over as acting manager of the Long Branch Light and Power Company. He returned to the estimating division of Toledo Edison in 1929 and was promoted to regulation engineer in 1935. He served the Institute as a member of the Toledo Section Executive Committee for several years. He was a member of the Ohio Society of Professional Engineers.

Johnston H. Hunt (AM '45), planning and design engineer, Toledo (Ohio) Edison Company, died March 17, 1953. Mr. Hunt was born in Somerset, Ohio, November 1, 1892, and received his bachelor of science degree in electrical engineering from Ohio State University in 1918. During World War I, he served as a second lieutenant in the signal corps. In 1919, Mr. Hunt joined the Toledo Railway and Light Company, the forerunner of the Toledo Edison Company, as a cadet engineer. In 1921 he was transferred to Cities Service Power and Light Company, New York, N. Y., as a statistician. He returned to the Toledo Edison Company in 1922 as an engineer. In 1950 he was promoted to planning and design engineer. He was a member of the Edison Electric Institute and the Association of Edison Illuminating Companies.

William Seymour Hadaway, Jr. (AM '94, M '96, F '13, Member for Life), retired, died April 12, 1953. Mr. Hadaway was born in Plymouth, Mass., August 24, 1866, and received his bachelor of science degree in physics from Massachusetts Institute of Technology in 1887. Mr. Hadaway had devoted his professional life to the improvement of electric heating appliances for industrial use and held more than 150 patents.

MEMBERSHIP • • •

Recommended for Transfer

The Board of Examiners at its meeting of April 16 1953, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the Secretary of the Institute. A statement of valid reasons for such objections, signed by a member, must be furnished and will be treated as confidential.

To Grade of Member

Bastian, A. L., project engineer, Ward Leonard Electric Co., Mount Vernon, N. Y.
Crain, C. M., associate professor of electrical engineering, University of Texas, Austin, Tex.
Cress, W. M., supervising engineer, Public Service Co. of Northern Illinois, Chicago, Ill.
Crooks, J. C., supervisor of work standards, Allison Div., General Motors Corp., Indianapolis, Ind.
Daroff, M. A., electrical engineer, U. S. Naval Air Development Center, Johnsville, Pa.
Fry, M., staff member, The Johns Hopkins University, Chevy Chase, Md.
Grosskurth, R. A., assistant command electrical officer, Royal Canadian Navy, Nova Scotia, Canada
Hadwin, T. F., substations superintendent, British Columbia Electric Railway Co., Ltd., Vancouver, British Columbia, Canada
Hamner, F. G., distribution engineer, Southern Services, Inc., Birmingham, Ala.
Hartman, A. E., instructor, Case Institute of Technology, Cleveland, Ohio
Heil, H. R., engineer, Columbus & Southern Ohio Electric Co., Columbus, Ohio
Hrovath, J. W., staff electrical engineer, Aluminum Co. of America, Cleveland, Ohio
T. K. Jefferis, Village Mgr., Grosse Pointe Shores, Mich.
Johnson, E. F., manager, commercial engineering dept., Clark Controller Co., Cleveland, Ohio
Johnson, W. M., supervisor, forced-cooled transformer engineering, General Electric Co., Pittsfield, Mass.
Kawecki, E., application engineer, General Electric Co., Schenectady, N. Y.
Laubscher, W. F., electrical engineer, Tennessee Valley Authority, Chattanooga, Tenn.
Leonard, L. V., system operator, Public Service Co. of Indiana, Inc., Plainfield, Ind.
Lincoln, E. W., manager, production planning, Fansteel Metallurgical Corp., North Chicago, Ill.
Mason, L. L., general foreman, Consolidated Gas, Electric Light & Power Co., Baltimore, Md.
Means, C. P., asst. research engineer, Bendix Radio Div., Bendix Aviation Corp., Towson, Md.
Money, L. J., member of technical staff, Hughes Aircraft Co., Culver City, Calif.
Nix, R. C., electrical engineer, Tennessee Valley Authority, Knoxville, Tenn.
Pizzorno, P. P., electrical engineer, Tennessee Valley Authority, Chattanooga, Tenn.
Powers, W. R., design engineer, General Electric Co., Fort Wayne, Ind.
Robbins, P. H., supt. of engineering, Metropolitan Edison Co., Reading, Pa.
Roberts, H. N., owner & manager, H. N. Roberts & Associates, Lubbock, Tex.
Sanderford, R. B., district engineer, Tennessee Valley Authority, Nashville, Tenn.
Schechter, M., electrical engineer, P. R. Moses & Associates, New York, N. Y.
Scorgie, D. G., physicist, Naval Research Laboratory, Washington, D. C.
Smith, L. M., electrical engineer, Bonneville Power Administration, Portland, Oreg.
Staats, G. W., engineer, Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Stuart, M. J., electrical engineer, Gilbert Associates, Inc., Reading, Pa.
Taylor, G. E., senior engineer, Oklahoma Gas & Electric Co., Oklahoma City, Okla.
TeWinkle, G. J., electrical engineer, Niagara Mohawk Power Corp., Buffalo, N. Y.
Thompson, J. R., sales engineer, Garland-Affolter Engineering Corp., Portland, Oreg.
White, H. F., senior electrical engineer, Jackson & Moreland, Boston, Mass.
Zanzie, C. E., electrical engineer, Sargent & Lundy, Chicago, Ill.

38 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership, in the grade of Member, have been received from the following candidates, and any member objecting to election should so notify the Secretary before June 25, 1953, or August 25, 1953, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Garrard, C. J. O., General Elec. Co. Ltd., Witton, Birmingham, England
Nelson, P. L., Chas. T. Main, Inc., Boston, Mass.
Ross, J. H., Consulting Engineer, 1251 Yonge St., Toronto, Ontario, Canada
Young, H. E. (re-election), American Locomotive Co., Schenectady, N. Y.

4 to grade of Member

OF CURRENT INTEREST

Television Microwave Equipment Provides Simultaneous Picture-Sound Relaying

Two new television microwave equipments were announced recently by the Raytheon Manufacturing Company. These are the first of a series of microwave and other communications products which are planned to meet the expanding requirement for equipment of advanced and flexible design in the communication industry.

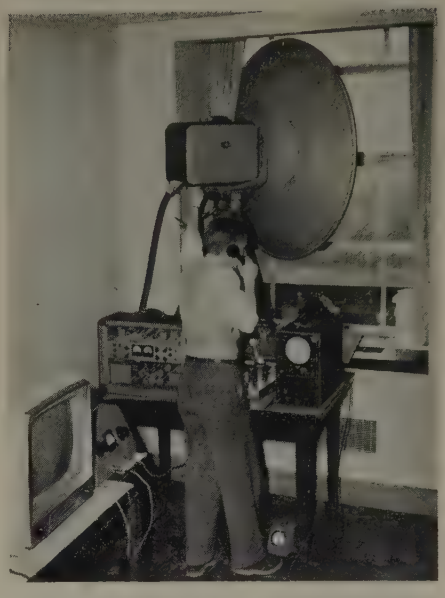
One of these new units is the *KTR-100* "Microlink," a compact, lightweight relay developed for use as a studio transmitter link, remote, interconnecting, radar relaying, or other broadband requirements. The other is the new *MTR-50* "Magnalink," a much larger link with great power for extended range and maximum fade protection.

The new *KTR-100* Microlink in addition to providing audio and video includes a completely new automatic frequency control and limiter, special cable compensating switch allowing use of up to 500 feet of cable, accurately controlled transmitter frequency, built-in voltage regulator, and provisions for frequency and modulation monitoring.

A new temperature-controlled fused quartz cavity, accurate to $\pm 1/2$ megacycle over the system operating range of -30 to $+50$ degrees centigrade, allows much greater frequency sensitivity and control.

Mechanical design is the most flexible and advanced yet offered to the industry. The complete system may be assembled or disassembled in a matter of minutes. Greater accessability of components and built-in provisions for testing the system during operation are added features in Microlink.

The equipment operates in the frequency range of 6,875 to 7,125 megacycles, with a power output of 0.1 watt. Input voltages are standard 115 volts alternating current. The entire system, composed of four suitcase-type cases and two parabolas, weighs less than 200 pounds.



Microlink operator "zeroes in" his parabola from an upper story of the John Hancock building in Boston, on the opposite unit which is set up on Mount Wachusett in western Massachusetts. Contact was made within a matter of seconds, and a strong, clear signal was received. The straight-line distance between units was approximately 40 miles

The model *MTR-50* Magnalink, a similar but much larger link, operates in the 2,000-megacycle frequency range, and is powe by a 50-watt magnetron. By virtue of n mal gain factors through a 10-foot parab the 50-watt tube output is multiplied res ing in erp (effective radiated power) 50,000 watts.

The Magnalink, used as a single hop re over a 140-mile path in the atomic tests Yucca Flats, Nev., also utilizes a system multiplexing the audio and video sign without deterioration of quality. Freque stability is maintained within $\pm .05$ per c by automatic thermostatic control of magnetron body temperature. Video quency response is flat within ± 1.5 decib to 6 megacycles and 100-per-cent modulat can be obtained with input signals as low 0.3 volt peak-to-peak.

All important circuits in both transmi and receiver are individually metered test points are provided for pertinent vi circuits.

The Magnalink receiver is of the sin superheterodyne type employing a *2* reflex klystron as a local oscillator an *1N21-B* crystal mixer. The intermedi frequency amplifier incorporates one noise input stage, two limiters, and a

Microlink's ease of assembly is demonstrated here as a Raytheon engineer fits the transmitting unit to its parabola. Machined guides assure a quick and perfect alignment, and the junction is watertight. The entire integrated unit is light enough to be picked up and moved about on a rooftop by one man

Future Meetings of Other Societi

American Management Association. General M agement Conference. June 17–19, 1953, Hotel Sta New York, N. Y.

American Society for Engineering Education. An Meeting. June 22–26, 1953, University of Flor Gainesville, Fla.

American Society for Testing Materials. An Meeting. June 29–July 3, 1953, Chalfonte-Had Hall Hotels, Atlantic City, N. J.

American Society of Heating and Ventilating E neers. Semiannual Meeting. June 29–July 1, 1 Shirley-Savoy Hotel, Denver, Colo.

American Welding Society. Spring Technical Mee and Welding and Allied Industry Exposition. J 16–19, 1953, Shamrock Hotel, Houston, Tex.

Conference of Basic Materials and Exposition of B Materials for Industry. June 15–19, 1953, H Roosevelt and Grand Central Palace, New York, N

Congress of Radiology. 7th International Cong July 19–25, 1953, Copenhagen, Denmark

Edison Electric Institute. 21st Annual Conventi June 1–4, 1953, Atlantic City, N. J.

International Union of Pure and Applied Phys Colloquium on Cosmic Rays. July 5–11, 1953, Bagn de Bigorre, France

International Union of Pure and Applied Phys International Congress on Electroacoustics and S posium on the Sound Insulation of Light-Weight St tures. June 16–24, 1953, The Hague, Hilversum, D and Eindhoven, Netherlands

National Society of Professional Engineers. An Meeting. June 18–20, 1953, Sheraton-Beach Ho Daytona Beach, Fla.

Pan American Railway Congress Association. 8th American Railway Congress. June 12–20, 1 Washington, D. C., and June 21–25, 1953, Atlantic C N. J.

Society of Automotive Engineers. Summer Meet June 7–12, 1953, The Ambassador and Ritz Carl Atlantic City, N. J.

The American Society of Mechanical Engine Semiannual Meeting. June 28–July 2, 1953, H Statler, Los Angeles, Calif.

atic gain control. Intermediate frequency 130 megacycles and bandwidth 17 megacles. Output signal variations under idely varying input signal conditions are evented. Two output stages provide video utputs of up to 2 volts peak-to-peak. The video bandwidth is flat within ±1.5 decibels to 6 megacycles.

This equipment embodies straightforward circuitry with ease of accessability of all components. All power supplies are electronically regulated.

et Pilotless Drones Collect Data on Radiological Hazards in Atomic Clouds

Details were released recently by the nited States Air Force and the Sperry yroscope Company of the robot system sed to control the Lockheed *QF-80* pilotless one aircraft participating in the nuclear sts now taking place at the Nevada Proving rounds.

The *QF-80* drones, a pilotless version of the andard Lockheed *F-80* jet fighter, will llect data of vital interest to the United tates Air Force regarding radiological azard in an atomic cloud.

A robot system of the Sperry Gyroscope ompany completely controls via remote eans the *QF-80*. The system enables NULLO" flight (no live operator aboard) the *QF-80* under direction by radio nd radar from the beep-box control signals om two ground stations worked by specially ained "beep pilots," or from a nearby jet director" aircraft.

The pilotless jet takes off and lands itself, nd firmly holds any compass course, altiude, or speed. While air-borne it maneuvers asily, from take-off speed to Mach limit, nd from sea level to 40,000 feet. The *QF-80* orrects itself for any unwanted deflections nd holds constant air speeds, even while utomatically adjusting for nose-up or nose-own angles of flight. Accurate control can e maintained up to full capacity of the airraft, through take-offs and climbs, dives, vel flight, flat turns, and bank turns.

Pilotless aircraft now are found in several iversified applications as: a target drone r weapon testing, evaluation, and radar acking; a data-gathering vehicle for use tests such as at the Nevada Proving rounds or in special structural tests, both ypes presenting hazard to human life if anned aircraft were employed; a target one for weapon testing, evaluation, and radar tracking; a training vehicle capable of both manned and remote-control flight for instruction of drone-director crews; and as a research tool to penetrate hitherto unexplored aerodynamic and physical regions without hazard to human life.

One vital element of the *QF-80* system is the Sperry *E-4* precision autopilot, similar to the one which automatically flies long-range jet bombers on precision courses.

The remote control system of the *QF-80* provides a degree of exact, automatic control of jet air speeds not attainable before. Such stabilized air speeds is a critical matter in landings and precision maneuvers. The use of drones in atomic tests in Nevada demonstrate the progress made in "mating" radio, radar, gyroscopes, and servomechanism into integrated systems of flight control.

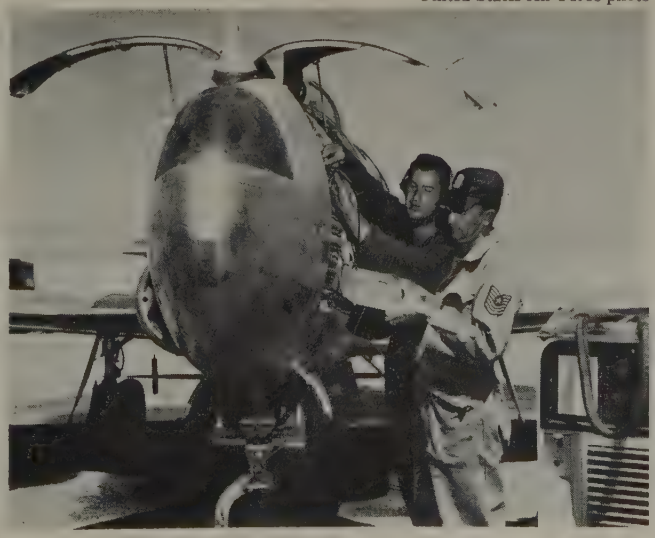
A typical *QF-80* mission step-by-step follows:

The ground "beep pilot" takes his station on a platform near the runway, before a little black box equipped with switches, push buttons, and lights. One switch has a long handle, resembling a miniature airplane control stick. Off at one side are the radio receivers and transmitters and power generators.

When the pilotless jet is lined up on the runway, the beep pilot checks various controls through his black box, and control surfaces of the airplane move instantly in response. He pushes one button for automatic take-off sequence, then "beeps in" throttle increase by triggering a switch in short pulses. Another button releases the brakes, and as the drone gathers speed, the ground pilot beeps in left or right signals to hold the jet to the center of the runway.

Further stages of the take-off are completely automatic. At 110 miles per hour, preset climb is introduced. At 150 miles per hour, the landing gear retracts. At 160 miles per hour, the wing flaps also retract, and the pilotless craft is air-borne. From this point on, control may be passed, if desired, at any time to another beep pilot with more compact but similar controls in a *DT-33* director airplane.

United States Air Force photo



ir Force mechanics Indian Springs Air orce Base are shown libirating radio-ontrol equipment in Lockheed QF-80 rone (pilotless air-raft) which was used penetrating a radio-tive cloud resulting om an atomic de-nation during a re-ent nuclear test at e Nevada Proving Ground

Oak Ridge Summer Symposium to Be Devoted to Modern Physics

The Fifth Annual Oak Ridge Summer Symposium will be devoted to modern physics this year after 3 years dealing with other fields of science. The symposium will be held from August 24 to August 29, 1953, and will consist of several lectures within the general fields of mesons and ultra-high-energy phenomena on the one hand and electromagnetic radiations on the other.

Speakers on the symposium will include: Jesse W. Du Mond, California Institute of Technology; Ralph Livingston, J. Rand McNally, and T. A. Welton of the Oak Ridge National Laboratory; M. Stanley Livingston, Massachusetts Institute of Technology; and J. Steinberger, Columbia University. Specific subjects to be covered include mesons, cosmic rays, microwave, infrared, and optical spectra, gamma-ray spectroscopy, quadrupole moments, and quantum electrodynamics.

This will be the second in the series of Oak Ridge summer symposia to be devoted to modern physics. The first symposium 5 years ago was concerned with this field, and subsequent gatherings have been devoted to a review of modern chemistry and discussions of the role of atomic energy in engineering and in agriculture.

The symposia are sponsored jointly by the Oak Ridge National Laboratory and the Oak Ridge Institute of Nuclear Studies. Additional information may be obtained from the University Relations Division of the Institute, P. O. Box 117, Oak Ridge, Tenn.

Occupational Safety Guide Lists Accident Prevention Aids

The National Safety Council's new Occupational Safety Service Guide provides company safety directors with a complete catalogue of the many and varied accident prevention aids available from the Council.

In the service guide, company safety men will find not only the tools they need to build their plant safety programs, but also the training aids available for instructing supervisors and workers.

For the safety man, the guide offers the Council's periodicals, newsletters, and a complete library of technical and administrative publications covering all phases of occupational accident prevention. Information on the subjects covered in the basic and advanced courses of the Council's Safety Training Institute also is included.

To assist the foreman, the service guide offers a monthly magazine, 24 training films that show supervisors how to use basic human traits in building a better safety program, and several hundred made-to-order 5-minute safety talks.

A full line of posters, films, and booklets

are available to sell safety to the man on the job.

Copies of Service Guide *2.1* can be obtained without cost by writing the National Safety Council, 425 North Michigan Avenue, Chicago 11, Ill.

Screw Thread Manual Contains American and Unified Standards

According to George T. Trundle, Jr., Chairman, Board of Directors, Trundle Engineering Company, an important and necessary handbook has been published by The American Society of Mechanical Engineers (ASME), culminating 50 years of argument, conference, and compromise.

Titled "ASME Screw Thread Manual," it is a shop and drafting room abridgement of the American and Unified Standards for screw threads and their gauges. The volume contains the American standards and those that were set by the Accord of 1948 signed by Canada, Great Britain, and the United States. The agreement was designed to assure the interchangeability of screws and threaded products of those nations.

The book should be of value to every engineer and draftsman who deals with threaded screw parts.

The "ASME Screw Thread Manual" may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y., at a price of $2.50 per copy.

Atomic Energy Converted to Electricity in Power Test

The homogeneous reactor at Oak Ridge (Tenn.) National Laboratory produced usable amounts of electric power on February 24, 1953, when it was brought to its full design operating load of 1,000 kw. The occasion was marked with ceremonies befitting the successful operation at full load of the first reactor of this type with a power potential as well as the second instance of the production of electricity from atomic energy in this country. The other such instance was in a heterogeneous reactor at Arco, Idaho, in December 1951.

The homogeneous reactor will produce both electricity and fissionable material, making it of great interest in view of the impending development of dual-purpose reactors. The solution itself serves as the coolant. It is pumped through a heat exchanger to produce steam, which in turn drives a turbine-generator to produce electricity.

The Oak Ridge reactor went critical on April 15, 1952, construction on it having begun in March 1951. The reactor underwent a thorough period of testing at low power before being tested at full power. Experimental work will continue at high power to acquire information regarding the feasibility of this type for full-scale reactors. For the first short period of top-power level operation, the reactor produced twice as much electricity as needed by its own building and the excess was fed into the Oak Ridge National Laboratory electric system. At full operation 150 kw of electricity was produced.

Announcement of the successful project was made jointly by the Atomic Energy Commission and the Union Carbide and Carbon Corporation, which operates the Laboratory.

New Metal Detector to Protect Crushing Machinery Announced

A new metal detector especially engineered to meet the needs of quarries, coal mines, and other mining-type industries for the protection of crushing machinery has been developed by the Industrial Equipment Section of the RCA Victor Division, Radio Corporation of America.

The new equipment, which normally would be installed between the primary and secondary crushing operations, consists of two units—the detector itself framing the aperture through which will pass the conveyor carrying the product being inspected, and a small control unit.

The detection aperture is fashioned to suit a variety of primary belt conveyors, and the frame is so designed that it can be separated into two parts for installation and rejoined around the belt. The aperture is completely weatherproof to permit outdoor operation. The inspection coils are adjusted so that the equipment will detect any pieces of tramp metal, magnetic or nonmagnetic, large enough to damage the crushing machinery, but will not stop operations for small unobjectionable metal objects.

The electrical change induced by the passage of metal through the aperture of the new equipment can be used to activate any kind of signaling device, or to stop the conveyor belt to prevent the tramp metal from reaching the second crusher. The detector will give satisfactory performance at conveyor speeds of up to 600 feet per minute, the company stated.

Only two controls are needed to operate the equipment. The control unit is connected to the detector by means of a 3-conductor metal-shielded cable. This unit is easily portable, measuring $8^1/_4$ inches high, $6^3/_4$ inches wide, and 10 inches long, and weighing only about 20 pounds. The equipment operates on 115 volts, 50 to 60 cycles, and consumes approximately 70 watts.

Special Summer Programs Are Announced by MIT

Massachusetts Institute of Technology (MIT) has announced special summer courses in transistors, digital computers, feedback control systems, and an advanced course in fluid power controls for 1953.

The program in "Transistors and Their Applications" will be held from July 20 to 31. Approximately one-fourth of the program will be devoted to a development of the theory of the operation of transistors, starting from physical principles. A portion of the program will be devoted to laboratory experiments and attention will be focused on the ultimate possibilities of the transistor for the solution of engineering problems.

The potentialities of modern electronic processing systems will be emphasized during the program on "Digital Computers and Their Applications" from August 24 to September 4. The program is especially designed for those unfamiliar with digital computers who must determine how computing systems can be applied to their problems and the advantages that might accrue. No previous training or experience beyond a bachelor's degree in business, science, or engineering will be required.

The special program presenting a formalized theory for the analysis and synthesis of "Feedback Control Systems" will be given from June 22 to July 3. The first week of the MIT course will be devoted to a review of the theory of measurement and feedback control. The second week will deal with advanced subjects, such as contactors, pulse control mechanisms, data sampling, distributed parameter systems, pneumatic and thermal systems, random signals and load and nonlinear systems.

The advanced course in fluid power controls will be given from July 6 to 17 and is designed especially for engineers whose work is in some phase of the fluid power controls field. Highlights of the program will include discussions of the fundamentals of fluid flow, new concepts of flow valve performance and design, and the generation and utilization of compressible and incompressible fluid power. Analytical and simulation techniques for studying the dynamics of valve-controlled systems will be discussed and there will be appropriate laboratory demonstrations. Enrollment will be limited to those whose industrial and educational experience will enable them to contribute to and benefit from the program.

Further information and application blanks for any of these summer programs may be obtained from the Director of the Summer Session, Room 3-107, Massachusetts Institute of Technology, Cambridge 39, Mass.

Unique Measuring System Predetermines Picture Quality

Unprecedented mathematical accuracy in predetermining the quality of image any given television or photographic system will produce was reported recently as the result of progress on a unique measuring system which permits for the first time the scientific grading of picture-producing instruments.

The progress was outlined in a technical paper by Otto H. Schade, RCA Tube Department engineer.

Eighteen months ago, Mr. Schade disclosed his system of universal ratings which can be applied to measure with scientific objectivity the quality of all image-producing instruments—camera and projection lenses, television camera and picture tube and positive and negative motion-picture film. He now has outlined the use of the system to translate optical properties of images into electrical terms.

The new application is based on the establishment of electro-optical equivalents to permit accurate expression of optical characteristics in mathematical language he explained. For example, many significant properties of an image depend upon the characteristics of its "star" image (image of a point source of light). The

of electro-optical equivalents shows the image of an optical "circuit" to be the terpart of the impulse response of an ric circuit. Accordingly, the mathecal relations between electric impulse nses, frequency characteristics, and edge itions can be applied to compute counrt properties of optical star images.

ne importance of the electro-optical valents to the television and motion re industry, Mr. Schade said, is that can be applied to grade accurately the ity of the elements of any image-prong system. The gradings, in turn, e it possible to predetermine mathecally the quality of the picture which ystem is capable of producing.

nversely, knowing the picture-quality ired, equipment designers can apply electro-optical equivalents to determine characteristics required by each element ny image-producing system to produce quality, he said.

illustrate, Mr. Schade pointed out the measuring system has been applied etermine the requirements of a theater ision system capable of moving-picture ity. Having measured the quality of dard motion pictures, it was possible pecify the characteristics of television era tube, optical system, projection scope, and other elements required for a theater television system.

is scientific approach points the way to num equipment design, he declared. etofore, the picture quality of television photographic systems has been deter-d visually. The ratings system will le the motion picture industry, film essors, lens makers, and television tube ufacturers to determine quickly and rately with electronic instruments the acteristics of basic elements of television photographic systems and to apply the urements against mathematical optis.

iners Simulate Lighthouses Increase Safety in the Air

lying lighthouses" are being adopted by nercial air lines in the United States as latest move in their constant effort to ase aerial safety.

ese lighthouses-in-the-sky are the air-s themselves, many of which henceforth carry a high-intensity rotating beacon nted high atop the vertical fin of the tail nbly. Greater safety in the air is the cted result.

ght source for the beacon is a 4½-inch-eter lamp of the sealed-beam type, de-ed especially for this purpose by the ral Electric Company. Company esmen said the new lamp will indicate an ane's presence at greater distances, both and night, than do present standard s.

e lamp, which produces a light beam of 0 candlepower, nearly 50 per cent er than that of an automobile head-, was developed for United Air Lines the Civil Aeronautics Administration. ast two air lines now are equipping their , and others are expected to adopt this safety device.

e light source, mounted in a fixture h rotates the beam horizontally, is visible from all points of the compass. A colored glass dome fitted over the lamp and rotating mechanism produces a deep-red beam. The fixture itself was developed by United Air Lines.

Quicker and easier identification of airliners is provided by a new rotating beacon light, mounted atop the tail assembly. A powerful new sealed-beam lamp developed for the unit by General Electric produces a beam 50 per cent more powerful than that of an automobile headlamp. Inspecting the light are two engineers of the United Air Lines, which developed the marker

The new beacon light is seen as greatly reducing the danger of 2-airplane collisions during darkness or other poor-visibility conditions, and making the visibility and identification of airplanes easier in normal daylight seeing situations.

Colloidal Graphite Used in Atomic Battery

An "atomic battery," a new product of our age, has been developed. This device, possessing far-reaching potentialities, is already perfected to a point where it delivers a small current almost indefinitely. "Aquadag," a dispersion of colloidal graphite in water, is used to form an anodic coating on the positive electrode in the battery cell.

Primarily a metrological tool at this stage of its development, the atomic battery plays an important part in the manufacture of new instruments for precise measurement of radioactivity. It also can be used to measure liquid levels, liquid interfaces, specific gravity, temperature, and pressure (or vacuum). Further possibilities, much different, exist for such functions as measurements of corrosion rates and analyses of alloys and of gases.

Philip E. Ohmart, president and director of research of the Ohmart Corporation, Cincinnati, Ohio, is the inventor of the battery. It was he who evolved a method of utilizing radioactivity in the generation of electric energy. His theory, which makes use of a gas as an electrolyte after ionizing it by exposure to nuclear radiation, was developed during his work as leader of a research group.

It has been found that a cell with electrodes of lead and gold—far apart on the electromotive series—delivered a small current when the air surrounding them was exposed to radiation from as little as 25 millicuries of radium. When the pole connections were reversed, the current likewise reversed its direction. This showed that the electric current being generated in the cell, with a gaseous electrolyte, was a result of radioactivity. To check this theory, an airtight cell was built. As this cell was evacuated, the current dropped steadily. Upon further evacuation, the current fell to zero. (And when a high degree of vacuum was established, a negative current resulted.)

After the initial work with lead and gold as electrodes, Aquadag was found to be more suitable as the positive electrode because graphite is beyond gold on the electromotive series. Other forms of carbon were tested but the highest positive potential for this type of electrode is produced by the colloidal graphite. It is also the most stable. Thus, Aquadag made possible the improved Ohmart cell now in use. This product is also employed for treating surfaces of Ohmart's instruments to eliminate contact-potential current or other stray electricity.

An atomic battery has been built which

Philip E. Ohmart, inventor of the atomic battery, with a cell used for the detection of beta particles. Aquadag is used as an electrode in the cell because it is more electrically positive than gold, which was previously tried

will deliver enough current to run a very small electric motor. Mr. Ohmart does not claim his invention to be a feasible source of power for mankind, but the Ohmart cell does make possible a battery for use where only a trace of current is needed.

ECPD Announces Pamphlet on Careers in Engineering

Engineers' Council for Professional Development (ECPD) has prepared a pamphlet entitled "Engineering—A Creative Profession," to aid in encouraging young people to choose engineering as a career.

The pamphlet discusses the meaning of engineering and the different phases it may take. It also tells what the prospective engineer should study in high school and how he is trained in the engineering colleges. The various branches of engineering are described in detail and the opportunities and fields of work are pointed out.

The pamphlet is available from ECPD, 29 West 39th Street, New York, N. Y., price 25¢ per copy; 20¢ per copy in quantities of 50 or more.

Group Asks Charter to Spur Use of Atom in Industry

A group of leading businessmen, engineers, scientists, and educators interested in the development of industrial uses for atomic energy has reported filing papers of incorporation with the Secretary of State, Albany, N. Y.

The group, to be known as Atomic Industrial Forum, Inc., will not be a lobbying group, according to W. L. Cisler (F '47), spokesman for the group.

Outlined objectives of the forum, said Mr. Cisler, will be

1. To foster and encourage development and utilization of atomic energy in accordance with the best traditions of American democracy and free competitive enterprise.

2. To provide a forum in which individuals and organizations may consult and co-operate in solving problems relating to atomic energy and which concern the nation, industry, or the general public.

3. To promote dissemination, consistent with national security, of knowledge and understanding relating to development of atomic energy.

4. To foster and encourage research and development relating to atomic energy.

There will be two classes of membership with the entire operation financed by dues. Regular members will be those who are lawfully entitled to access to restricted data as defined in the Atomic Energy Act of 1946. This group will have sole voting privileges and membership on the board of directors will be limited to them.

Special memberships will be open to individuals, corporations, associations, partnerships, and trusts which are interested in development of atomic energy.

The forum will maintain present headquarters in the Engineering Societies Building, 29 West 39th Street, New York, N. Y.

Study Indicates Computers Impractical for Meter Reading

Results of a study applying computing machines to watt-hour meter reading and billing are described by J. R. Macintyre and W. C. Israel in a paper on "Watt-Hour Meter Reading and Billing" presented at the AIEE Winter General Meeting in January 1953.

Although results at the present time seemed to show that telemetering and computing systems were impractical in this field, it was hoped that others would give thought to the problem and perhaps arrive at a solution.

The study showed that it is not economically feasible to apply a telemetering system to the meter reading problem, using any existing schemes. Meter telemetering could be made economically feasible only by the invention of new telemetering methods; possibly in conjunction with new metering means adapted to telemetering. At present, the authors did not know of any promising possibilities in that field.

An economic study of a portable bill computer also was undertaken. The bill computer was visualized as a portable device designed to work with punched tabulating card equipment as used in many systems of utility accounting. It would be carried by the meter reader, and would record the meter reading on suitable punched cards, calculate usage charges, and print a bill. It was estimated that savings in billing and accounting would be obtained, although an increase in cost of meter reading time would be expected.

A survey using the portable bill computer showed an increase in cost of meter reading and billing, so further work in this field is not anticipated.

NEW BOOKS • • • • •

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

BERECHNUNG MAGNETISCHER FELDER. (Technische Elektrodynamik, Volume 1.) By Franz Ollendorff. Springer-Verlag, Vienna, 1952. 432 pages, 9¾ by 6¾ inches, bound. $15.70. This book on the calculation of magnetic fields, first of a proposed series of six volumes on "Technical Electrodynamics," is intended both for the designer in the electrical industry and the engineer in the plant laboratory. Dealing chiefly with the mathematical analysis of fields the book also considers graphical methods. Important topics covered include the following: field calculations of synchronous and asynchronous machines; leakage theory of autotransformers; determination of the pulling forces of split-pole systems, gripping plates, and magnetic separators; and qualitative descriptions of certain measuring devices.

CHEMICAL PROCESSING OF WOOD. By Alfred J. Stamm and Elwin E. Harris. Chemical Publishing Company, Inc., 212 Fifth Avenue, New York, N. Y., 1953. 595 pages, 8¾ by 5¾ inches, bound. $12. A comprehensive presentation of information on the chemical utilization of woods, especially of wood residues and inferior species of wood, to produce modified wood products, pulp products and various derived chemicals. Both conventional and new methods are included with emphasis on the more recently developed processes. As introduction to the specialized sections, the first few chapters are devoted to the basic physical and chemical properties of wood. The book cons a critical survey of the extensive literature on the s and presents both the favorable and unfavorable fe of each process together with the economic limit

DESCRIPTION OF A MAGNETIC DRUM CULATOR. (Annals of the Computation Labor Volume XXV.) By the staff of the Compu Laboratory. Harvard University Press, Camb Mass., 1952. 318 pages, 10¾ by 8 inches, bound This volume describes the design and construction Mark III Calculator, an electronic digital calc employing rotating magnetic drums for the stor numerical and instructional information. It the subroutines for the computation of the eleme functions, provides a manual of operation, and the detailed coding for the solution of four illust problems. The necessary information is given f maintenance and improvement of the machine a as for its use in the solution of problems.

ELECTRIC CONTROL SYSTEMS. By Ri W. Jones. John Wiley and Sons, Inc., 440 Avenue, New York 16, N. Y., third edition, 1953. pages, 9¼ by 6 inches, bound. $7.75. The pr concern of this book is with control systems for drives, with emphasis on the utilization of e power. Aspects of control in generation and mission are not considered. The author concen on basic types, emphasizing the functional aspe control, rather than attempting a complete treatm all control elements and systems. Most of the d sion is devoted to systems having no feedback, b essential features of feedback systems are introd A list of references accompanies each chapter.

THE ELECTRICAL MANUFACTURERS, 1900. By Harold C. Passer. Harvard Univ Press, Cambridge, Mass., 1953. 412 pages, 9 6½ inches, bound. $6. This book is a study origins and developments of the electrical manufac industry and of the men, called engineer-entrepre who were responsible for them: Brush, Edison, We house, Sprague, Thomson, and so forth. The b organized in three parts: arc lighting, incand lighting, and electric power within which are consi four major analytical problems—entrepreneu technical change, competition, and economic gr Neither a technical history nor a conventional eco history, the book's emphasis is on the forces that br major changes in the industry and the manner in technological innovations became effective in bu A summary chapter includes suggestions for policy made on the basis of the study.

ELECTRODYNAMICS. (Lectures on Theo Physics, Volume III.) By Arnold Sommerfeld. lated by Edward G. Ramberg. Academic Press, 125 East 23d Street, New York 10, N. Y., 1952. pages, 9¼ by 6¼ inches, bound. $6.80. In the author discusses general fundamentals and the principles of Maxwell's electrodynamics. In P the several classes of phenomena, in static, stati quasistationary, and rapidly variable fields, are d from Maxwell's equations. Part III, on the the relativity and electron theory, is limited to the s theory of relativity and the theory of the indi electron. The electrodynamics of moving me developed in Part IV. Waveguides and a num other special topics are considered in their proper in the treatise, which closes with a considerable s of illustrative problems.

TRANSMISSION TELEPHONIQUE. Theori Lignes. By R. Croze and L. Simon. Editions Ey Paris, France, 1952. 368 pages, 9¾ by 6¼ i paper. Ffrs. 2,960. A textbook covering both and practical application. Part I deals with the a of transmission-line characteristics, covering prima secondary parameters, distortions in transmission, lines, and other important topics. Part II provi extensive discussion of the problem of crosstalk.

SYMPOSIUM ON FLAME PHOTOME American Society for Testing Materials, 1916 Street, Philadelphia 3, Pa. (Special Technical P tion Number 116) 1952. 120 pages, 9 by 6 paper. $2. The 11 papers included in this posium present a brief review of flame photo describe several currently used photometers an cedures, discuss certain special problems, and gi tailed methods for some specific determinations, tetraethyl lead in gasoline. References to other m accompany most of the papers.

HIGHLIGHTS.....

1952 Index. The 1952 Index to *Electrical Engineering* is being distributed with this issue as Section 2. It is subdivided into subject, author, AIEE and non-AIEE news, and biographical indexes.

1952 Engineering Developments. At the close of each year, the many achievements and developments in the field of electrical engineering during the past 12 months are considered and evaluated. In this issue a picture survey reflecting some of the year's significant engineering developments is presented, and a number of the AIEE technical committees review various outstanding engineering developments of 1952 that fall within their particular scopes (*pages 1–24*).

Winter General Meeting. The largest technical program in the history of the Institute will be featured at this year's Winter General Meeting in New York, N. Y. Some 85 sessions and conferences include papers in all of the AIEE's divisions of technical activities. A full and varied schedule of inspection trips has been planned also. These include the backstage facilities of Radio City Music Hall, United Nations General Assembly Hall, the Harbor Radar Installation of the Port of New York Authority, and the United States Naval Supply Depot (*pages 75–84*).

Of Current Interest. Among items of current interest this month is the report of a new continuous coal mining system for the handling of coal in outcrop seams by remote control. The mining rig for this operation is a self-propelled double-decked steel structure mounted on four hydraulic jacks (*pages 94–5*). Another development is the establishment of a calibration service by the National Bureau of Standards to determine the permeability of magnetic materials (*pages 95–6*).

News Index

Effective Technical Lectures. Some hints on how to make the presentation of technical material more interesting are offered particularly for the benefit of those who plan to present papers at the Winter General Meeting. To be effective, and easily grasped by the listener, such material should be planned carefully and coordinated with simple and attractive illustrations (*pages 84–5*).

Electric Glass Welding. The extension of the electric welding process to include glass has opened up a vast new field to the electrical art. With this process, higher temperatures, a faster heating rate, and accurate control of the heat are possible (*pages 31–4*).

Manpower Shortage in Power Education. In light of the many predictions concerning the shortage of engineering graduates, a subcommittee of the AIEE Committee on Education undertook to ascertain the ratio of expected power to electronics graduates and circulated questionnaires to 136 schools. The results of this survey are presented and analyzed in this article (*pages 25–7*).

The Student Branches. The Student Branches of the AIEE offer to the student engineer an opportunity to broaden his professional acquaintanceship with other engineers and with the profession itself. Numbering but 15 in 1902, there are now 132 Student Branches constituting the Institute's greatest single source of membership (*pages 28–31*).

New Rectifier Tube. With the advent of new applications requiring higher and higher current and voltage levels, it has been necessary to develop a rectifier tube capable of meeting such requirements. This article describes such a tube employing a thoriated tungsten filament (*pages 51–6*).

Electronic Equipment in Fighter Aircraft. Fighter aircraft must be capable of the functions which electronic equipment can provide, but such equipment must be of minimum size and weight with maximum reliability. Unfortunately, this is difficult to achieve with the present ununified approach to the situation (*pages 64–7*).

Aircraft Radio Interference Measurements. Interference pulses such as produced by corona and sparking phenomena in aircraft electric equipment present a serious problem in their measurements. While the noise level meter is of great assistance in determining the progress made in radio noise elimination, the high-speed oscillograph is of great value in this work (*pages 36–40*).

Computing Machines in Aircraft Engineering. A discussion of the use of these machines in aircraft work is followed by an evaluation of current machines, ideas about present and future needs, and some suggestions concerning how they can be met (*pages 43–8*).

Analogue Computer Studies of Power Lines. Such a serious condition as series resonance of the line trap and transformer or other termination has not usually been believed to exist at carrier terminals. The analogue computer can efficiently check countermeasures to eliminate it (*pages 58–62*).

Revisions in Transformer Standards. Recommended revisions in Standards for Temperature Rise Tests on Transformers have been approved by both the AIEE Standards Committee and the Test Code Subcommittee of ASA *C57* and are to be included in a revised edition of *C57.22* when further revisions under consideration are ready (*pages 70–4*).

Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems* contain the formally reviewed and approved numbered papers (exclusive of ACO's) presented at General and District Meetings. The publications are on an annual subscription basis. In consideration of payment of dues, members may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office 20th & Northampton Streets, Easton, Pa. Editorial and advertising offices 500 Fifth Avenue, New York 18, N. Y. Subscription $12 per year plus extra postage charge to all countries to which the second-class postage rate does not apply; single copy $1.50 Entered as second-class matter at the Post Office, Easton, Pa., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925.
January 1953, Vol. 72, No. 1. Number of copies of this issue 55,400

THIS IS A BACK-CONNECTED

SWITCH BUSHING

This is a Lapp *standard catalog item.* In fact, you'll find it on page 91 of Lapp Catalog No. Seven, listed as Number 14188. It is one of the complete series of insulators listed on that page which match precisely the Lapp standard line of Indoor Bus Supports which are shown on pages 83-86 of the same catalog. By *"matching"* we mean insulators which have corresponding electrical, mechanical and physical characteristics.

We emphasize the point because the two series are wholly interrelated—the portions of corresponding insulators above the flange match exactly in height and diameter—physical strengths are the same—both series possess identical electrical characteristics. They may be used interchangeably, where other design considerations determine the choice of indoor bus supports or back-connected bushings.

In specifying Lapp indoor bus supports and back-connected bushings, you gain more than the convenience and efficiency of this interchangeability. You have also the benefit of assurance of single responsibility for all qualities, characteristics and performance of the insulators involved. You have not only the extra margin of security of Lapp porcelain, but the guarantee and responsibility of Lapp for electrical, mechanical and physical performance.

Both Lapp indoor bus supports and Lapp back-connected switch bushings are available from your switch manufacturers.

Lapp Insulator Co., Inc., Le Roy, N. Y.

Lapp

20 years and more of easier handling

Modern switchboards last 20 years or longer. During this period, you can expect periodic inspections, load changes, certain maintenance, and, of course, short circuits and overloads.

Consider the outstanding advantages to yourself of I-T-E *horizontal drawout* switchgear over the life of the equipment in each of the following instances:

When inspections are made

Truck-mounted circuit breakers can be wheeled out of compartments quickly and easily. Safety shutters isolate "live" contacts in the compartment. Connected equipment can then be examined carefully without danger to personnel.

When loads change

Relay settings are quickly adjusted to compensate for load changes. On wider load variations, current transformers may be changed. Isolation of compartments in Metal-Clad construction permits these changes without interference with the main bus. Circuit breakers may be removed from their compartments to assure complete safety. Horizontal drawout circuit breakers in drawout switchboards make this possible and *convenient*.

When maintenance is performed

Each circuit breaker is withdrawn from switchboard, checked, and adjusted if necessary. Service continuity is assured. While the circuit breaker is out of service, a spare can be used to replace it. One spare circuit breaker provides adequate insurance for many feeder circuits.

Your local I-T-E sales engineer will be glad to show you the specific advantages of Horizontal Drawout Switchgear in your own application. Or for complete details on I-T-E Metal-Clad Switchgear, send for Bulletin 7004-B, Dept. —, I-T-E Circuit Breaker Co., 19th & Hamilton Sts., Philadelphia 30, Pa.

I-T-E

METAL-CLAD SWITCHGEAR

I-T-E CIRCUIT BREAKER COMPANY
19TH AND HAMILTON STREETS • PHILADELPHIA 30, PA.
R&IE Equipment Division • Greensburg, Pa.

INDUSTRIAL NOTES ....

General Electric Notes. C. D. Bradrick has been appointed manager of manufacturing of the General Electric Company's Heat Pump Department, Bloomfield, N. J. Mr. Bradrick was formerly manager of industrial engineering for the manufacturing department of the General Electric Air Conditioning Division.

Dr. B. L. Vosburgh has been named manager of health services for the General Electric Company. Dr. Vosburgh, who is a leading authority in industrial medicine and long head of medical services at the Schenectady plant, will be functionally responsible for health and hygiene programs for about 215,000 employees in 125 plants.

Westinghouse Appointments. T. J. Newcomb has been appointed manager of the Television-Radio Division of the Westinghouse Electric Corporation with headquarters at Sunbury, Pa. Mr. Newcomb, who was formerly sales manager of the Westinghouse Appliance Division, Mansfield, Ohio, succeeds F. M. Sloan, who was named manager of operations for the Television-Radio Division. Mr. Sloan will be responsible for all the defense business of the Division and for the engineering and manufacturing of both defense and consumer products for the Division. R. J. McCusker has been named assistant sales manager of the Television-Radio Division.

Du Mont Promotions. Promotion of three members of the Instrument Division, Allen B. Du Mont Laboratories, Inc., Clifton, N. J., has been announced. H. B. Steinhauser, formerly a senior engineer, has been named manufacturing engineer. L. E. Florant, formerly an intermediate engineer, has been named head of the Engineering Services Section. A. W. Russell, formerly a senior engineer, has been appointed head of the Electrical Design Section.

R. W. Schmidt has been promoted to manager, Equipment Engineering and Maintenance, Cathode-Ray Tube Division. He was formerly assistant manufacturing manager.

Stromberg-Carlson News. Appointment of Schueler-Dollar Wholesale Distributors, Fort Wayne, Ind., as Stromberg-Carlson distributors has been announced by that company's Television-Radio Division.

E. G. Flood has been named field engineer for the Sound Equipment Division, and will cover the larger part of New York State and parts of Pennsylvania, Vermont, and Massachusetts.

Stackpole Appointments. Dr. E. I. Shobert has been appointed manager of carbon research and engineering for the Stackpole Carbon Company, St. Marys, Pa., and Henry M. Dressel will serve as director of research and engineering for the firm's electronic components division.

Other Stackpole appointments include: L. D. Andrews, director of research and engineering on magnetic materials; E. F. Kiefer, director of research and engineering on carbon products; and F. X. Sorg, director of research and engineering on fixed resistors.

Simmonds Starts Construction of New Plant in Vermont. Simmonds Aerocessories, Inc., has announced that construction has started on a new plant in Vergennes, Vt. The new facilities will be used primarily for housing additional machine tools and is the first of a contemplated section building which will include the engineering and administrative activities of the Simmonds Vergennes manufacturing operations.

Arthur D. Little Forms International Division. Arthur D. Little, Inc., Cambridge, Mass., has announced the establishment of an International Division to meet the demand for its services in international areas. The new Division is headed by A. G. Haldane. This Division will serve to co-ordinate assignments so that clients abroad can draw upon the services of the company's entire staff.

New Location. Hytron Radio and Electronics Company has announced a new location for its eastern sales office at 32 Green Street, Newark 2, N. J.

Change in Company Title. Lewis and Kaufman, Ltd., becomes the new title of Lewis and Kaufman, Inc., electron tube manufacturers of Los Gatos, Calif. The change is concurrent with the absorption of personnel and facilities of the Saticoy, Calif., plant of Pacific Electronics. Lewis and Kaufman top management remains as before.

Syntron Store. The Syntron St. Louis Sales Company has announced the opening of a new store at 4431 Manchester Avenue, St. Louis, Mo.

Sales Office Move. Removal of the Newark, N. J., sales office of the Reliance Electric and Engineering Company from its present location at 1060 Broad Street into new quarters at 535 High Street in Newark has been announced. The telephone number remains unchanged.

Wight Appointed Philco Public Relations Director. William Wight has been appointed director of public relations of Philco Corporation, Philadelphia, Pa. Mr. Wight was formerly Washington vice-president of Carl Byoir and Associates.

Speakman Appointed Manager of Fairchild Guided Missiles Division. Edwin A. Speakman has been appointed general manager of the Fairchild Guided Missiles

(*Continued on page 20A*)

from qualitative indicators
to *precision measuring* devices . . .
with the *new*

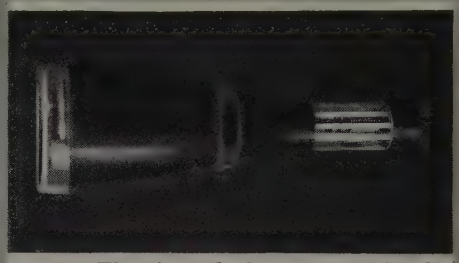
tight-tolerance

CATHODE-RAY TUBES
by
DU MONT

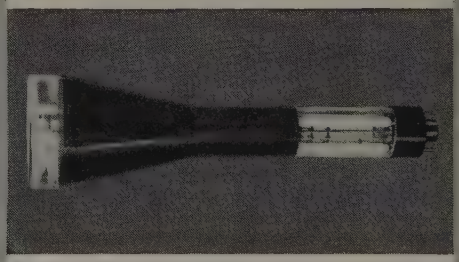
Compare the first of the new Du Mont line of high-precision cathode-ray tubes, the Types 5ADP- and 3WP- with similar cathode-ray tubes, previously available. Notice the improved resolution without loss in brightness, the greatly tightened tolerances on all critical specifications, the greatly increased sensitivity, and the characteristics now specified that have never before been published:

ITEM	5CP-A	5ADP-	3GP-	3WP-
Angular Alignment	90° ± 3°	90° ± 1°	90° ± 3°	90° ± 1°
Grid Cutoff per Kv of Eb2	30V ± 50%	30V ± 25%	33V ± 50%	40V ± 25%
Deflection Factor DCV/in/KV of Eb2 D1D2 D3D4	 46V ± 15% 39V ± 15%	 30V ± 10% 23V ± 10%	 80V ± 20% 70V ± 20%	 46V ± 10% 32V ± 10%
Line Width	No spec	.03" max.	No spec	.026" max.
Pl Light Output	No spec	15 ft. L. min.	No spec	7 ft. L. min.
Modulation[1]	No spec	45V max.	No spec	50V max.
Deflection Non-Linearity	No spec	2% max.	No spec	2% max.
Pattern Distortion[2] Square size A Square size B	No spec	 3.075" 2.925"	No spec	 2.050" 1.950"
Minimum Useful Scan D1D2 D3D4	 ± 2¼" from center ± 2¼" from center	 ± 2" from center ± 2" from center	 ± 1⅜" from center ± 1⅜" from center	 ± 1¼" from center ± 1⅛" from center
Face Plate	Curved	Flat	Curved	Flat

[1] The amount of grid voltage required to drive the tube from cutoff to specified light output.
[2] With a raster pattern adjusted so that wider points just touch Square A, no point will lie within Square B.



5ADP- Flat face, high-sensitivity 5-inch cathode-ray tube for medium and low accelerating potentials.



3WP- The 3-inch version of the Type 5ADP- with flat face and high sensitivity.

5XP-A High-voltage tight-tolerance cathode-ray tube unilaterally interchangeable with the Type 5XP-.

* *Available in Production Quantities write for prices*

ALLEN B. DU MONT LABORATORIES, INC.
1500 Main Ave., Clifton, N. J.

(*Continued from page 18A*)

Division, Wyandanch, N. Y. Mr. Speakman has been vice-chairman of the Research and Development Board, Department of Defense, for the past 2 years.

Walter Morris Joins Tempel. Walter J. Morris, recently superintendent of silicon products of the Warren, Ohio, mill of the Republic Steel Corporation, has become associated with Tempel Manufacturing Company, Chicago, Ill. Mr. Morris will devote himself exclusively to the proposed development and research program of the company which will consist of the improvement of the electrical characteristics of silicon steel, powdered metal, and iron flakes in this country and abroad.

Sales Representative. Appointment of Fletcher Sales Company, Louisville, Ky., as representative in the Louisville area has been announced by the Pacific Boiler Division, United States Radiator Corporation. Fletcher Sales Company will represent the entire line of Pacific Steel Boilers in both commercial and residential sizes.

McMillen Joins National Science Foundation Physics Staff. Dr. James H. McMillen has joined the staff of the National Science Foundation as a member of the physics staff of the Division of Mathematical, Physical, and Engineering Sciences. He comes to the Foundation from the Naval Ordnance Laboratory, where he was chief of the Hyperballistics Division.

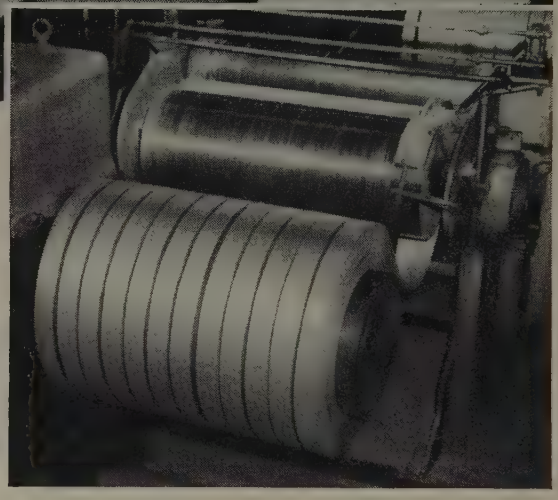
Kemper Appointed General Manager of Watson-Stillman Fittings Division. Jackson Kemper has been appointed general manager, Watson-Stillman Fittings Division, H. K. Porter Company, Inc., Roselle, N. J. Mr. Kemper will be responsible for all operating and sales activities of the division, formerly known as the Watson-Stillman Distributor Products Division of which he was sales head.

Henry Hill Joins Gunnison Homes. Gunnison Homes, Inc., United States Steel Corporation's housing subsidiary, has announced that Henry Hill, one of the nation's noted architects of homes, has joined the company as a consultant.

NEW PRODUCTS . . .

TV Signal Range Calculator. This Calculator shows the approximate Grade "A," Grade "B," and Principal City coverage for all very-high-frequency and ultrahigh-frequency television channels. Coverage radius is read directly, and with one rule setting, for stations operating with effective radiated powers from 10 to 1,000 kw, and for antenna heights up to 3,000 feet. This slide-rule-type calculator helps determine signal coverage due to change in transmitter output power, change in

(*Continued on page 24A*)



Re-winding coils after slitting to specifications. Armco works to close tolerances on widths, maintains clean slit edge.

How Armco DI-MAX coils can save you money

Customers report more than twice the average die life with Armco Di-Max, compared with standard hot-rolled electrical steel. This alone means substantial savings for them—and it can mean savings for you too. This is why:

Di-Max Quality meets the latest standards of flatness, ductility and finish in hot-rolled electrical steels.

Coils for Continuous Operation

Armco Di-Max Quality coils are made of sheets joined by smooth, ductile butt welds that are within thickness tolerances. Welded areas have the same electrical and mechanical properties as the sheets from which the coil is made. Besides prolonging die life, Di-Max coils permit continuous press operation, eliminate end-of-sheet scrap losses.

Adequate Insulation

Di-Max Quality electrical steels have adequate insulation for many applications. Where extra interlamination resistance is required, the steel is supplied with Armco No. 4 Insulation.

Grades in DI-MAX

Di-Max Quality is available in coils and cut lengths in any of the following hot-rolled grades: Armco Tran-Cor 72, 82, 101 and Electric.

The booklet, "Armco Hot-Rolled Electrical Steels" contains complete data on these steels. Write for a copy.

ARMCO STEEL CORPORATION

3322 Curtis Street, Middletown, Ohio
Plants and sales offices from coast to coast
Export: The Armco International Corporation

ARMCO

(*Continued from page 20A*)

antenna height, and change in channel frequency. Further information is available from Pioneer Electronic Supply Company, 2115 Prospect Avenue, Cleveland 15, Ohio.

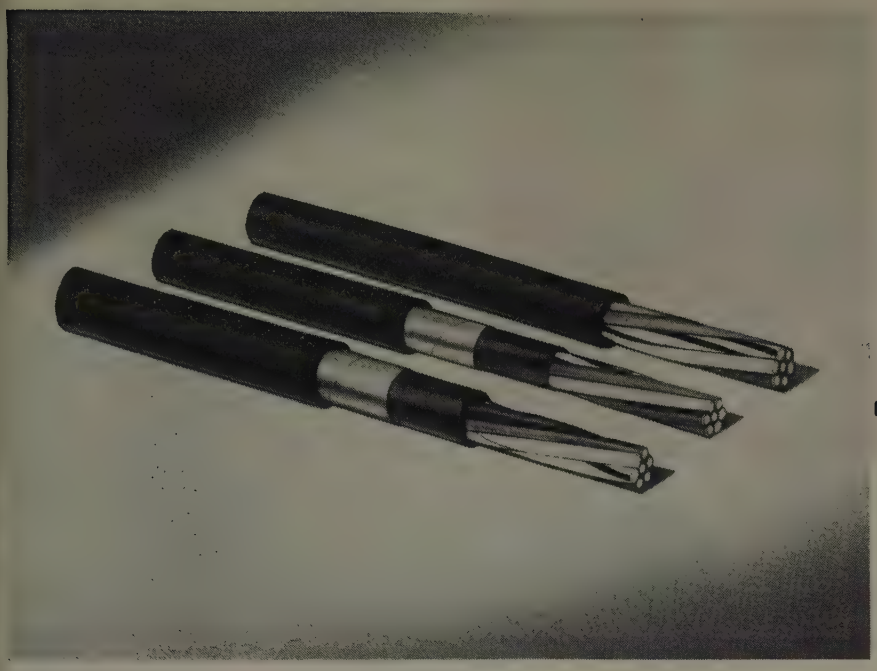
Metal-Sealing Plastic. A new plastic material has been developed that withstands continuous temperatures of 200 degrees centigrade and also possesses a high dielectric strength. It is particularly advantageous where hermetic sealing and gas sealing under pressure is needed for perfect functioning of electrical components. This new material, known as Melkorite, was developed by Melkor Research Laboratories, Inc., 11733 Detroit Avenue, Cleveland 7, Ohio, where additional information may be obtained.

Ion-Exchange Reactor. The Enley "PUP" Reactor is a liquid conditioning machine, servicing the entire field of ion-exchange, plus the removal of solid and gaseous media. It is the basic unit of a modular system, creating flexibility of design and production. It also provides, for the first time, a low-cost water demineralizer which may be regenerated by the user. Further information can be had by writing "PUP" Reactor Division, Enley Products, Inc., 254 Pearl Street, New York, N. Y.

Electronic Variable Speed Drive. The Arrow-Hart and Hegeman Electric Company has announced a development in motor control equipment, the Electronic Variable Speed Drive for fractional-horsepower motors. This is a low-cost packaged drive consisting of an electronic, adjustable-speed control unit driving a series motor. It provides a wide, stepless range of speed control with good speed regulation under varying loads. With the optional Dual Range feature, speeds from 100 to 3,500 rpm are available. The motor can be started, stopped, or dynamically braked and can be accelerated rapidly to preset speeds. The series motor makes use of both the a-c and d-c output from a single thyratron tube, and it is claimed that this results in much higher speeds at medium torque, much higher starting torque at slow speeds, longer tube life, and lower tube replacement costs. Further information may be obtained by writing to the Motor Control Division, The Arrow-Hart and Hegeman Electric Company, 103 Hawthorn Street, Hartford 6, Conn.

Conveyor Belt Weighing System. Development of a new conveyor-belt weighing system capable of electronically adding, subtracting, and recording the tons per hour of material delivered to one or more points was announced by the Trans-Weigh Company, Wayne, Pa., and the Industrial Division of Minneapolis-Honeywell Regulator Company, Philadelphia, Pa. The system continuously weighs material being delivered and provides running measurements of tonnage as well

(*Continued on page 26A*)



THESE THREE ARE "A NATURAL"

for LOW COST, TROUBLE-FREE OPERATION of SIGNAL, CONTROL and COMMUNICATION CIRCUITS

Here's a list of the top quality benefits you get when you buy Simplex Polyethylene-Plastex Signal Cables. For more complete information send for our newly-revised Simplex catalog #1010 in care of the address below.

POLYETHYLENE INSULATION

- High Dielectric Strength
- Low Dielectric Constant
- Low Power Factor
- High Insulation Resistance
- Good Physical Properties
- Low Water Absorption
- Resists Oils, Chemicals, Sunlight, Aging
- Low Cracking and Shattering Temperatures
- Resists Deformation
- Permits Use of a Thin Wall

PLASTEX JACKET

- Tough yet Flexible
- Low Cracking Temperature
- Wide Temperature Range
- Resists Abrasion, Oils, Chemicals, Flame, Sunlight, Aging
- Low Water Absorption and Diffusion

COMPLETED CABLE

- Small in Diameter
- Light Weight
- Low Capacitance and Attenuation
- Electrical and Mechanical Stability
- Comes in Three Types Shown Above for Duct, Underground and Aerial Service

Simplex - WIRES & CABLES

SIMPLEX WIRE & CABLE CO.
79 SIDNEY STREET,
CAMBRIDGE 39, MASS.

(*Continued from page 24A*)

as the total tonnage delivered over a period of time. These measurements can be transmitted over considerable distance either to a foreman's office or to a central control panel board. Chart records are also maintained automatically. If one large belt supplies several other belts at different places along its length, the system can add and subtract to measure the quantity supplied to any or all belts. In operation the conveyor belt rides over a set of three idlers, or rollers, which form a wide-based trough. The force exerted on these is measured by a strain gauge and the weight of the belt itself and other component parts is subtracted electrically. The final measurements, weight of the material, are fed into an electronic recorder which indicates and records the instantaneous flow and integrates the total weight passing on the belt.

Preset Decimal Counting Unit. The Berkeley Model *730* Preset Decimal Counting Unit is a direct reading electronic counter capable of producing output information at any selected count. It will operate at speeds up to 40,000 counts per second and resolve pulse pairs separated by as little as 5 microseconds. Each counter is a plug-in unit designed for ease of replacement and simplification of maintenance problems in high-speed counting equipment. The Preset Decimal Counting Unit counts from 0 to the preset number and produces an output pulse. By employing additional circuitry this output pulse can be used to reset the unit electronically. Presetting is accomplished by depressing one of the ten push-button switches mounted at the side of the unit. The preset units may be connected in cascade indefinitely to give any range of preset counts. Details are available from Berkeley Scientific Division, Beckman Instruments, Inc., 2200 Wright Avenue, Richmond, Calif.

Vinyl Adhesives. A complete line of vinyl adhesives is being manufactured by Chemical Development Corporation, Danvers, Mass. Used for bonding vinyl plastics to themselves and to wood, metal, glass, acrylic plastics, cloth, and other substances, these new materials are easy to apply and do not require heat, pressure, or any special surface preparation. Three products are currently available and each is suggested for a special set of conditions. CD Cement *201* consists of several strong solvents and penetrants and was developed for bonding vinyl film to itself. CD Cement *202* is a bodied or slightly viscous adhesive intended primarily for bonding vinyl film to itself. It is of particular value where fast assembly is essential or for use on rough or poorly mated surfaces. CD Cement *203* is an adhesive for bonding vinyl plastics to metal, glass, paper, leather, and many other surfaces. A technical bulletin is available on request.

High-Slip Motor. A new totally-enclosed fan-cooled high-slip induction motor, designed for use in acceleration of high inertia

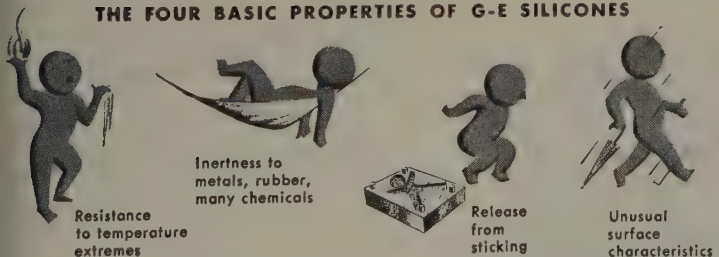
(*Continued on page 38A*)

HOW G-E SILICONES OFFER YOU

IMPORTANT SAVINGS THROUGH NEW DESIGN POSSIBILITIES

Lighter, more compact design! G-E silicones (resin SR-98) in Class H insulation made possible a 25% saving in critical copper in the redesign (right) of this atomic-hydrogen welder. G-E silicone insulation permits the welder to operate at higher temperatures—provides exceptional resistance to moisture and chemical fumes. Use coupon for more data on SR-98!

THE FOUR BASIC PROPERTIES OF G-E SILICONES



Here's an opportunity to save time, money and materials! Take advantage of the new design possibilities offered by General Electric silicones. For example, new Class H insulation made with G-E silicones permits drastic reductions in the size and weight of aircraft autotransformers. G-E silicone rubber makes possible longer-lasting jet engine seals, diesel gaskets and aircraft ducting.

WHAT CAN G-E SILICONES DO FOR YOU?

New design possibilities of silicones are suggested in an informative booklet *The Silicone Story*. Why not write for a copy today? In it you may find the key to improving a product or process . . . possibly even a clue to making an entirely new product! Just mail the coupon.

General Electric Company
Section 343-1B
Waterford, New York

☐ Please send me a free copy of *The Silicone Story*.
☐ Send me product data on SR-98.

Name_____
Firm_____
Street_____
City_____ Zone___ State_____

(In Canada, mail to Canadian General Electric Company, Ltd., Toronto.)

G-E SILICONES FIT IN YOUR FUTURE

GENERAL ELECTRIC

(*Continued from page 26A*)

loads, has been announced by the General Electric Company's Small and Medium Motor Department. Designated as Type *KRX*, the motor is as much as 30 per cent smaller and 40 per cent lighter than conventional totally-enclosed fan-cooled high-slip motors. The space and weight reduction is the result of the motor's extended-bar design which provides efficient dissipation of the increased heat normally generated by high-slip motors. In the new motor, low-resistance rotor bars are extended on one end and pass through a rotating baffle plate. Beyond the baffle plate, the bars are brazed to strips of high-resistance metal, shaped to form a radial-blade fan. These fan blades provide the higher rotor resistance necessary for high-slip characteristics. The Type *KRX* motor is available in 30 to 150 horsepower at 900 and 1,200 rpm, 5–8 and 8–13 per cent slip. Voltage ratings are 220, 440, and 550.

Weather-Sensing Equipment. Motorola, Inc., has announced the development of a new weather-sensing unit known as the "Snow Detector." This unit, designed primarily for the deicing of microwave antennas, has numerous applications. Wherever severe icing conditions and snowfall impair the operation of moving parts, an electronically controlled heater can solve the problem. The unit, only $7\frac{1}{4}$ inches in diameter, detects precipitation when the ambient temperature drops below 37 degrees Fahrenheit. An integral heater melts the snow and ice. No power is consumed either by the detector or by heaters at higher temperatures. Fully automatic, the detector will turn on heating elements whenever icing conditions exist. Up to 30 amperes at 117 volts alternating current can be switched without external relays. The heaters will remain on until the icing hazard is past, being automatically turned off by the detector.

RCA Tubes. The Tube Department, Radio Corporation of American, has announced the development of the following types of tubes.

The *6BQ7-A* is a medium-mu twin triode of the miniature type designed for use as the first radio-frequency amplifier tube in very-high-frequency television-receiver tuners or as a low-noise intermediate-frequency preamplifier tube in ultrahigh-frequency television receivers employing a crystal mixer. This tube has high transconductance, low input capacitance, low input loading, and low plate-to-cathode capacitance. The transconductance value of 6,400 micromhos obtainable at a plate current of only 9 milliamperes permits high gain and reduced equivalent noise resistance. The low input loading minimizes induced grid noise and makes practical a high input-circuit gain even in the high-frequency channels. Variation of the gain-control bias voltage produces a relatively small change in input loading so that the antenna termination is substantially constant. The low plate-to

(*Continued on page 42A*)

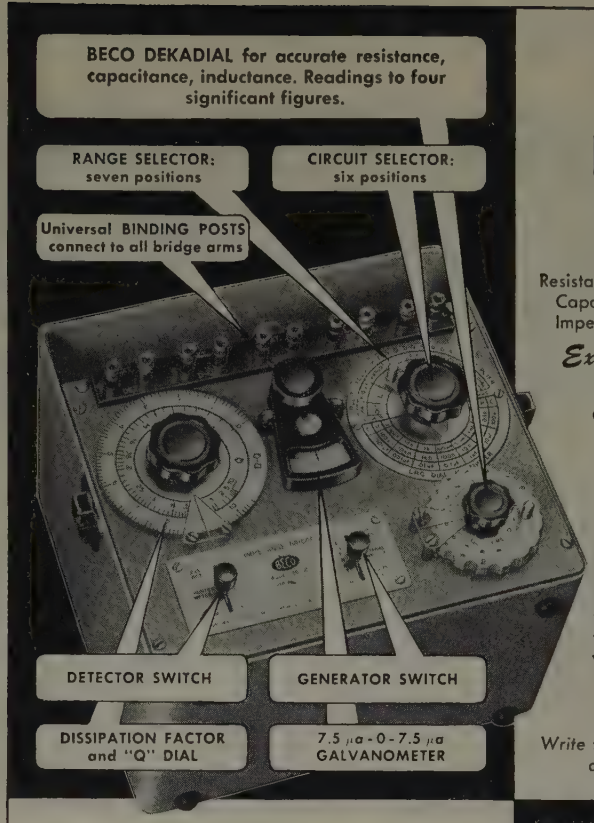
LOOKING INTO THE Impervious

You're looking into the most effective hermetically-sealed precision resistor yet developed. And this is only one of a complete line of precision wirewounds that makes Shallcross the leading producer for JAN-R-93, Characteristic A applications.

The secret of this leadership is the Shallcross patented hermetic-sealing process. It is your guarantee of unsurpassed resistor stability under wide temperature variations and high humidity—even total salt water immersion. No part of the resistance wire is exposed outside the resistor bobbin nor is any part of the terminal within the sealed unit. Expansion or contraction of the terminal therefore has no effect on the resistance wire joint or on the effectiveness of the seal.

For details on all Shallcross hermetically-sealed precision resistors for JAN and MIL applications, write for Bulletin L-27 with Supplement 1. SHALLCROSS MFG. CO., 11 Lincoln Ave., Collingdale, Penna.

Shallcross



BECO

IMPEDANCE BRIDGE

Wide Range

Resistance: 1 milliohm to 11 megohms
Capacitance: 1 mmf to 1100 mfs.
Impedance: 1 mh to 1100 henrys

Exceptional Accuracy

Resistance: ±0.1%
Capacitance: ±0.25%
Inductance: ±1.0%

◆

SHOWN MODEL 250-C1 $340

9"x11"x11" over-all. Convenient operation from battery, or from AC power lines with Beco accessory amplifier

◆

Write to factory for literature and analysis of your needs.

BROWN ELECTRO-MEASUREMENT CORP.

4635 S. E. HAWTHORNE BLVD.
PORTLAND 15, OREGON

photograph it!

A photo record is quicker, more accurate; and it may prove to be priceless.

THE ADVANCED single-lens reflex design of the 35-mm. PRAKTICA FX makes it easier for you to get expert photomicrographs, oscillographs, extreme close-ups, copy work, etc., in black and white or natural color. Use it for: Recording lab and field observations, quality control, inspections, photographing equipment in field, training personnel, etc. Excellent for the home photographer, too. From $99.50 to $199.50 (tax incl.).
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Position.....
Company.....
Address.....
City.....Zone...State.....

(*Continued from page 38A*)

cathode capacitance contributes to st bility in radio-frequency grounded-gr service.

The *12V6-GT* is a beam power tube the heater-cathode type intended primari for use in the output amplifier of automobi radio receivers operating from a 12-vo storage battery. The application directed electron beam principles in th design of the *12V6-GT* makes it capable producing relatively high power outp with high power sensitivity.

Solder Seal Terminals. General Cerami and Steatite Corporation has announce a line of hermetically-sealed terminals f use on metal enclosures for component These terminals are extremely resista to severe mechanical and thermal sho and are unaffected by rough shop handlin and prolonged subjection to high solderin temperatures. Additional information w be supplied by General Ceramics an Steatite Corporation, Keasbey, N. J.

Dynamotor. A compact new dynamoto Model *ES-129*, which performs the sam functions as three conventional dynamotor has been announced by Electro Enginee ing Products Company, 609 West Lak Street, Chicago, Ill. The company asser that this new, 4-commutator dynamot will operate with equally efficient pe formance from 6, 12, or 24 volts pow supply. Output is 500 volts at 0.10 ampere. The *ES-129* dynamotor is i tended for continuous service, with a rat temperature rise of 50 degrees centigrad The outstanding feature of this unit is i specially designed, dynamically balance armature containing four windings. Com plete information may be obtained fro the company.

Precision Air-Meter. Highest accuracy the measurement of air velocity, couple with instantaneous, direct readings, a now possible with the Precision Air-Mete made by the Hastings Instrument Com pany of Hampton, Va. With accura better than $1^1/_2$ per cent and respon time less than 1 second, the Air-Meter designed for all applications requiri exact measurement. It is especially d signed for applications such as air pollutio studies, smog research, weather statio applications, and laboratory work requi ing the highest degree of accuracy measuring air velocities. Readings a unaffected by temperature variation radiation, or normal fluctuations in atmo pheric pressure. The power supply is normal 110-volt 60-cycle outlet. Furth information may be obtained by writi the Hastings Instrument Company, Ham ton 10, Va.

Coaxial Cable Connector. Teletron Laboratories has developed a new mini turized radio-frequency coaxial cable co nector designed for use at "X" band fr quencies with either RG 55/U or RG 58/ coaxial cable. This new radio-frequen connector shows a voltage standing wa

(*Continued on page 46A*)

(*Continued from page 42A*)

ratio of less than 1.3 over the entire ba operating between 8,400–9,600 me cycles. Compression sealed against mo ture and atmospheric changes, this co nector is manufactured from brass, tefl phosphor bronze, and beryllium copp Further information is available from t manufacturer: Teletronic Laboratori Inc., 1835 West Rosecrans Avenue, G dena, Calif.

Lightweight Aircraft Motor. Weighi only 20¾ pounds, a new aircraft mo which develops 10 horsepower for co tinuous duty is being produced at t Aircraft Division of U. S. Electrical Mot Inc. Available with output shaft spe of 11,000 or 7,300 rpm, this unit is w suited for such applications as cont actuators, hoists, bomb bay doors, and forth, and is designed to meet Air Fo specification 32590. Operating on 4 cycle 3-phase alternating current, t motor offers such features as prepack ball bearings, splined take-off shaft, ra acceleration, and high torque. For ad tional information, write to U. S. Electri Motors Inc., Aircraft Division, Termi Annex (Box 2058), Los Angeles 54, Cali

High Speed Trigger. The Walkirt Co pany has announced the Type *M15* High Speed Trigger. This is a Schm type circuit designed to meet the w need for a fast pulse suitable for drivi many types of counting or scaling equ ment from a sine wave input. The u can be driven also from a square wa input, in which case it acts as an amplif and will produce pulses of either posit or negative polarity. The 150-volt pe output has a rise time of 0.2 microsecc and a fall time of 0.45 microseco measured to 90-per-cent amplitude. F further information on this product, co tact Wesley Kirchoff, Chief Engineer, T Walkirt Company, 145 West Hazel Stre Inglewood, Calif.

TRADE LITERATUR

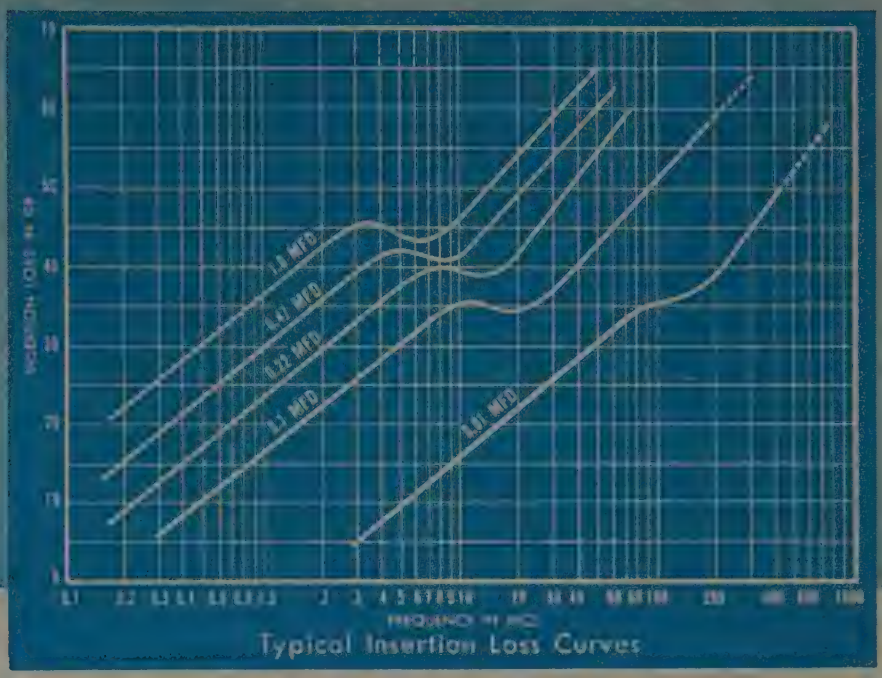
Glass-Jar Batteries. A 20-page catalo titled, "Gould Stationary Batteries Auxiliary Power and Control," has b published to help industrial users se and install the proper glass-jar batte in control, alarm, telephone, switchg and signalling services. The catalo discusses features, suggested uses, proper installation procedures for stati ary batteries. Exploded views sh battery components and tables pres technical data, over-all dimensions, weights for each type and capacity battery. It is available without cha from Gould-National Batteries, Inc., Ti ton 7, N. J.

Sound-Powered Electric Phones. Wheeler Insulated Wire Company, D sion of The Sperry Corporation, Wa bury 20, Conn., has released a bull

(*Continued on page 48A*)

THE MOST EFFECTIVE CAPACITORS FOR R-F NOISE SUPPRESSION...

...are the NEW SPRAGUE THRU-PASS® CAPACITORS



Typical Insertion Loss Curves

THRU-PASS CAPACITORS are a new Sprague development for use in radio interference reduction in communication and radar equipment.

• Thru-Pass Capacitors not only reduce to a negligible value the effect of external connection inductance to a capacitor but they also have a minimum length of internal path for radio interference currents. *Their performance is closer to that of a theoretically ideal capacitor than that of any other paper capacitor!*

• Electrically, Thru-Pass Capacitors are three-terminal feed-thru devices which are connected in a circuit in a manner similar to a low pass filter; the tab or lead terminals are connected in series with the circuit being filtered while the case is grounded.

• The threaded-neck mounting on Type 102P and 103P Subminiature Thru-Pass Capacitors is designed to give a firm metallic contact with the mounting surface over a closed path encircling the feed-thru conductor and to eliminate unwanted contact resistance so that the theoretical effectiveness of these new units is realized in practice. The milled flats on the threads help ensure vibration-proof mounting since the capacitors cannot rotate if mounted in a flatted opening instead of the usual circular hole.

• Type 102P and 103P Capacitors are all hermetically encased. Glass-to-metal solder-seal terminals are employed in order to assure positive protection against severe atmospheric conditions.

• Both types are impregnated with Vitamin Q, Sprague's exclusive inert synthetic impregnant, in order to provide maximum insulation resistance and minimum capacitance change with temperature. Type 102P units are processed for −55°C to +85°C operation while Type 103P units have their top operating temperature extended to +125°C.

• Engineering Bulletin 215 gives full details and standard ratings. Write on your business letterhead for your copy to Sprague Electric Co., 321 Marshall St., North Adams, Massachusetts.

TYPES 102P AND 103P 5 AMPERE THRU-PASS CAPACITORS SHOWING CHOICE OF LEAD OR TAB TERMINALS

SPRAGUE

WORLD'S LARGEST CAPACITOR MANUFACTURER

EXPORT DIVISION: CABLE SPREXDIV, NORTH ADAMS, MASS.

"THRU-PASS" AND VITAMIN "Q" ARE SPRAGUE TRADEMARKS.

(*Continued from page 46A*)

covering sound-powered communicatio equipment for industrial and commerci use. The line includes the Pair Tel phone System, Multiservice Intercor munication System, and a Master Te phone System, together with detail listing of special service equipment a high level handsets. Installation inform tion, wiring and dimension diagrams, a description of special instruments also a included. Copies of the bulletin may obtained from the company.

Ferrite Recording Heads. Increasing u of Ferroxcube nonmetallic ferromagne cores for recording heads in various typ of magnetic recorders has resulted fro the introduction of a new material, ty *7-90-7*, developed especially for th purpose. This new Ferroxcube materi is very homogenous and is more near free from voids and cracks than mo commercially available ferrites. Technic information on this new material is ava able in bulletin *FC-5103* upon letterhe request to the Application Engineeri Department, Ferroxcube Corporation America, 345 Marshall Street, Nor Adams, Mass.

Tungar Bulbs. An 8-page data manu on Tungar bulbs (used for rectifying a power to d-c power) has been announc as available from the General Electr Company, Schenectady 5, N. Y. De ignated *GEA-5677*, the bulletin contai charts and graphs illustrating the chara teristics, construction, operation, and a plication of Tungar bulbs.

Radiotelephones and Direction Finde Eight radiotelephone models, two rad direction finder models, and various a cessory units are described in a ne catalogue issued by the Applied Ele tronics Company, Inc., 1236M Folso Street, San Francisco 3, Calif. Besid a description of the basic design featu of these units, the catalogue includes full tabulation of models showing numb and types of channels, frequency rang receiver sensitivities, transmitter pow outputs, tube complements, power requi ments, dimensions, and weights.

Electrical Laminations. A complete li of electrical laminations and the spec oriented steel used in their manufactu is described in a catalogue offered Thomas and Skinner Steel Produ Company. Materials, specifications, a plications, test results, and actual s drawings of special and standard shap are described, along with specificati tables and graphs. Copies are availa from Thomas and Skinner Steel Produ Company, 1124 East 23d Street, dianapolis, Ind.

Circuit Breakers. A manual explaini operating principles of basic circuit breal designs and providing engineering data factors of application has just been pu lished by the Heinemann Electric Co

(*Continued on page 52A*)

FAST, SIMPLE OPERATION OF G-E COIL-TURN COUNTER SPEEDS DETERMINATION OF TURNS IN AIR-CORE ELECTRIC COILS

Coils tested before assembly boost production

New G-E Coil-turn Counter accurately determines effective turns

Production line testing of air-core electric coils is quickly and easily done with General Electric's new coil-turn counter.

Coils to be tested are placed over the test rod and connected to test clips. Operator depresses foot switch, energizing the reversing relay and thus reversing the magnetizing current in the rods. Dials are adjusted with each reversal until there is no galvanometer deflection. Number of turns can then be read directly from the dials.

Extremely accurate specifications can be met with this simple, comparative test. Fast testing allows immediate rejection of coils not meeting acceptable tolerances early in stage of manufacture, cutting costs and boosting production.

Standard coil-turn counter has rods $\frac{9}{16}''$ or $\frac{1}{4}''$ in diameter. Models are available with ranges of 0–11,100 turns, 0–31,100 turns, or 0–61,100 turns.

For more information about this or other electric testing equipment contact your nearest G-E Apparatus Sales Office or write for Bulletin GEC-819 to General Electric Co., Section 687-113, Schenectady 5, New York.

You can put your confidence in—

GENERAL ELECTRIC

(*Continued from page 48A*)

pany. Included in the manual ar simplified diagrams showing the thre basic types of circuit breakers in genera use today with brief descriptions. Throug colored charts and diagrams, explanation of temperature factors, inrush curren effects, tripping and reset time, and tim delay curves are provided. Also discusse are the questions of quick or slow make and-break, and wire deterioration rates a various ampere values. Copies of th manual are available upon request to th Heinemann Electric Company, 325 Plum Street, Trenton 2, N. J.

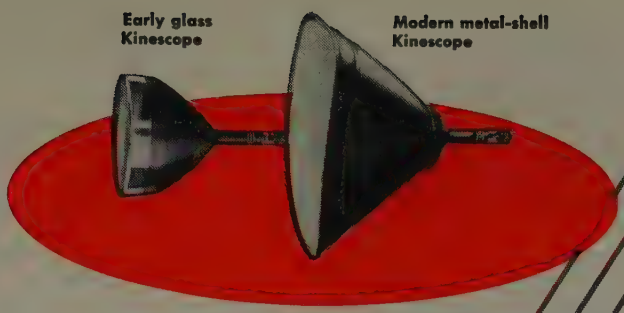
Relays for Industry. A complete line o telephone-type relays, including hermet cally sealed (in metal and glass containers subminiature, plug-in types, and others is described in a new, illustrated brochur released by Automatic Electric Company 1033 West Van Buren Street, Chicago 7 Ill.

Side-Positioning Regulating Control Application and operation of side-position ing controls are described in a new bookle available from the Westinghouse Electri Corporation. When these automati photoelectric controls are applied to web of material, they serve to maintai the traverse position with relation to th processing machine. Unwind and rewin stand control are the two main categorie of side-position control described. Equip ment used with each method is describe and illustrated, and a characteristics cha provides quick selection of the righ system. For a copy of this bulletin *DB 18-530*, write Westinghouse Electri Corporation, Box 2099, Pittsburgh 30, Pa

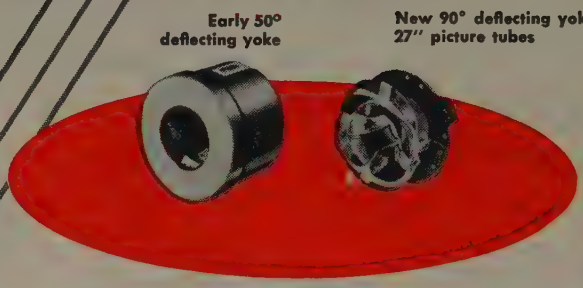
Noncontrol Precision Instrument Minneapolis-Honeywell Catalogue *152* contains factual information concernin ElectroniK noncontrol precision instru ments, which employ a potentiometer Wheatstone bridge, or other measurin circuit to measure temperature, pressure flow, pH, and other variables. Actuall a handbook for engineers' and buyers use, the literature presents detailed spec fications for each particular model. Als included is information on specially adapte ElectroniK instruments such as the Elec trometer, Function Plotter, Scanning Sy tem, Television Dial Recorder, Doubl Range Precision Indicator, and Consol Desk Precision Indicator. This literature available from Minneapolis-Honeywe Regulator Company, Brown Instrumen Division, Station 64, Philadelphia 44, Pa

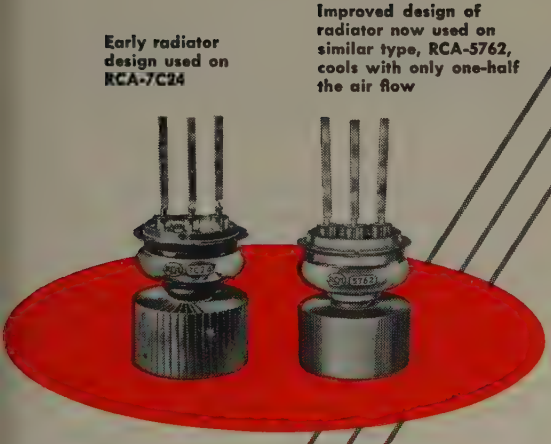
Radiation Detection and Health Instru ments. A 16-page illustrated brochur describing in detail all types of radiatio detection and health instruments, has bee issued by Radiation Counter Laboratorie Included are electronic instrument Geiger, proportional and scintillatio counters; health instruments; shields an safety devices. Catalogued for the fir time is complete reactor control instru mentation. Copies are available fro

(*Continued on page 54A*)



IN PRODUCT IMPROVEMENT RCA NEVER STANDS STILL





IT IS ONE THING to develop new products for the market. It's another thing to improve them . . . to conceive advanced designs . . . after they are on the market.

RCA engineers take nothing for granted—even after design has been "frozen." RCA engineers continue to work closely with equipment designers to solve problems dealing with the performance of tubes and components. RCA engineers never "let go" in their efforts to provide the ultimate in useful performance of the product.

Take the tubes and components illustrated here. ● The improved rectangular kinescope features a metal shell which permits use of a reflection-free faceplate having uniform thickness and high quality; it weighs less; it allows new flexibility in chassis layout. ● The improved plate radiator of the power tube reduces operating temperature, increases tube life, saves customers' money. ● The improved deflecting yoke provides beam deflection through a diagonal deflection angle of 90°—with inherent compensation for deflection defocusing. ● The improved rectifier tube has a greater reserve of emission, greater stability, longer life . . . is better suited for TV receiver requirements.

You can rely on RCA engineering leadership for continuous product improvement.

RADIO CORPORATION of AMERICA

ELECTRON TUBES **HARRISON, N.J.**

(*Continued from page 52A*)

Department FP-11, Radiation Counte Laboratories, Inc., 5122 West Grov Street, Skokie, Ill.

Rotomotive Equipment. A Jack an Heintz Technical Bulletin Number *135* describes Rotomotive Equipment for stand ard and custom aircraft electric motor and electric and hydraulic actuator Data on product features and performanc are given for small high-speed motor submersible fuel boosters, refueling pum motors, and specially designed actuator This bulletin is available without co from Jack and Heintz, Inc., Cleveland Ohio.

Industrial Electronic Instrumentation A 32-page booklet issued by Berkele Scientific Division, Beckman Instrument Inc., describes electronic instruments pro viding direct-reading digital presentatio of information and their principal industria applications. It covers high-speed count ing, counting plus control, precise interva timing, measurement of rpm, pressure temperature, flow, viscosity, velocity, fre quency, distance, and is available withou charge from Berkeley Scientific Division Beckman Instruments, Inc., 2200 Wrigh Avenue, Richmond, Calif.

Seamless Mechanical Tubing. A new bulletin, designed to help the tubing use in determining whether he should use ho finished, cold drawn, or "rotorocked seamless mechanical tubing as the basi for his product, has been issued by th Tubular Products Division of The Babcoc & Wilcox Company. Known as *TE 340*, the bulletin outlines the difference in methods of production, surface finish tolerances, and costs of tubing finished b the three processes. Copies of the bulleti are available, free, upon request to th general sales offices of the division at Beave Falls, Pa.

Mica Capacitors. The Sprague Electri Company has released a comprehensiv catalogue on its transmitter-type mic dielectric capacitors which conform wit Joint Army–Navy Specification *JAN-C-* Designated Catalogue *31*, this new re erence for engineers and purchasin agents consists of 32 pages of illustration engineering drawings, and technical cha acteristics of each unit. Copies are avai able upon letterhead request to Spragu Electric Company, 321 Marshall Stree North Adams, Mass.

Microwave Equipment. DeMornay Bonardi, Inc., Los Angeles, Calif., hav announced a catalogue on microwav engineering. The 134-page volume com bines the features of a textbook and manua The opening pages are devoted to a explanation of the basic concepts of micro waves. On succeeding pages, phases o microwave test equipment measuremen and calibration procedures are illustrated and equipment manufactured by De Mornay-Bonardi, Inc., is described.

HIGHLIGHTS.....

Winter General Meeting. As this issue goes to press, electrical engineers from all parts of this country and abroad are attending the 1953 Winter General Meeting of the Institute at the Hotel Statler in New York, N. Y. The week's activities, including a record number of technical sessions, will be reported in the March issue.

Of Current Interest. "A major problem in the construction of nuclear reactors is that of handling radioactive materials during tests and laboratory analyses." With the "hot laboratory" described in this issue, this testing can now be done almost completely by remote control (*pages 180–1 and cover*).

International Electrotechnical Commission. Some 26 technical committees of the IEC discussed international agreement on electrical standards at a series of meetings held last fall at Scheveningen, Holland. The United States was represented by 14 delegates, including the president of the Commission, H. S. Osborne, who reports herein on the results of the meetings (*pages 101–04*).

Radio Aids to Navigation. With the advent of electronic aids to navigation, the mariner no longer need take into account in his reckoning weather conditions over which he has no control. One of the earliest aids is the radio direction finder; among the more recent are the loran and radar systems developed during World War II (*pages 109–14*).

D-C Motor as Capacitor. Data are given for 1- and 220-horsepower motors. These capacitances are so large that their capacitative reactances at commercial frequencies are less than the armature resistances. Thus, as they stand, these capacitances could be exploited only at frequencies under 1 cycle per second (*pages 154–5*).

News Index

Electric Power and the Atomic Bomb. On December 5, 1952, ground was broken at Madison, Ind., marking the beginning of construction of a new power plant for the generation of electric energy to be utilized in the Atomic Energy Commission's diffusion plant now being constructed near Portsmouth, Ohio. When completed in 1956, the new power plant is expected to generate almost ten billion kilowatt-hours per year (*page 108*).

The EDVAC. The Electronic Discrete Variable Computer has a mercury-acoustic high-speed memory, binary number system, and serial presentation of data. It can handle problems that the ENIAC, Electronic Numerical Integrator and Computer, its predecessor, cannot handle due to its comparatively small memory capacity (*pages 159–62*).

Electronic Components in Great Britain. The search for improved quality in radar and radio equipment has been intensified, especially in the field of miniature and subminiature components. How this is being done in England is described (*pages 167–9*).

New Push-Pull Methods of Pole-Top Resuscitation. All these methods were found to be $1^1/_2$ times as efficient, measured by pulmonary ventilation, as the standard pole-top method. The double rock method was considered the best of those evaluated (*pages 132–7*). However, a discussion of this study questions whether the present method has been proved ineffective and the advisability of adopting a new method which has such disadvantages as requiring more working space than is available in many cases and is more difficult to perform if the victim is larger than the operator (*pages 137–40*).

Pioneer Large-Scale Completely Electrified Products Pipe Line. The experience gained from 10 years' operation of this pipe line, which has bought all its power from utility companies and entrusted all communications to the telephone company, are described. Ideas for future changes in pipe lines are given also (*pages 140–2*).

Mica Plate for High-Temperature Applications. Mica is an excellent insulator, but for most applications must be built up from splittings suitably bonded together. For low-temperature applications resins are used, but high temperatures require the use of inorganic binders having a melting point only slightly below the disintegrating temperature of the mica. To produce high-heat plates having the desired mechanical and electrical properties, a most critical selection of binder constituents must be combined with careful co-ordination of temperature and pressure during manufacture (*pages 145–50*).

Industrial Television. Industrial television fulfills a definite need by reducing accidents, operating costs, and capital investment. It even can provide, under certain conditions, greater intelligence than is possible by direct observation. Representative installations are examined and its future potential evaluated (*pages 125–30*).

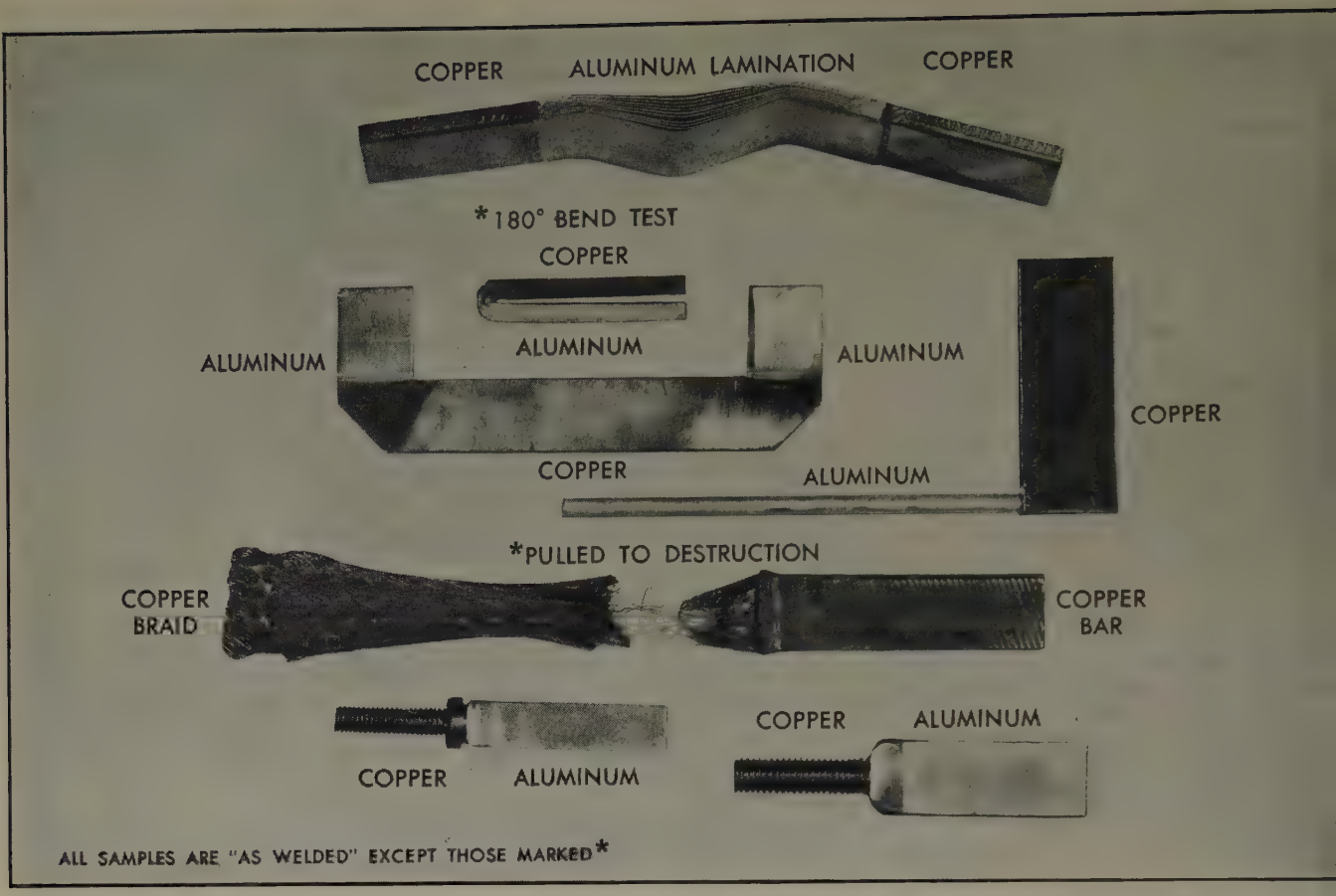
Oil Industry in Louisiana. Oil is discussed in terms of its relationship with other major world energy sources and its specific role in Louisiana where gas and oil have become the largest single industry (*pages 104–07*).

Computers. A review of past and present trends in computers is presented together with a discussion of certain important problems facing designers, as well as users, of computers today. The article emphasizes technical and sociological trends and concerns itself more with digital than with analogue computers (*pages 116–21*).

Bimonthly Publications

The bimonthly publications, *Communication and Electronics, Applications and Industry*, and *Power Apparatus and Systems* contain the formally reviewed and approved numbered papers (exclusive of ACO's) presented at General and District Meetings. The publications are on an annual subscription basis. In consideration of payment of dues, members may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office 20th & Northampton Streets, Easton, Pa. Editorial and advertising offices 500 Fifth Avenue, New York 36, N. Y. Subscription $12 per year plus extra postage charge to all countries to which the second-class postage rate does not apply; single copy $1.50. Entered as second-class matter at the Post Office, Easton, Pa., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925. February 1953, Vol. 72, No. 2. Number of copies of this issue 55,500

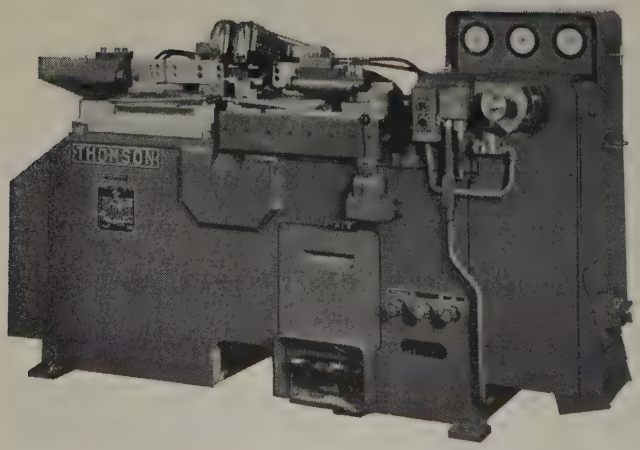


The Solution to the Problem of TERMINATING ALUMINUM CONDUCTORS In Production

We remind manufacturers serving the electrical industry that resistance welding offers a ready-made solution to the problem of terminating aluminum conductors in production. Joining aluminum to aluminum or aluminum to copper is a well-established practice in other fields. Suitable equipment exists; appropriate techniques can readily be developed for assembling terminals, connectors and other fittings for cable and conductors of the type used in the power and utility fields. Aluminum wire and cable of the type used in the building, automotive and aircraft industries and in the manufacture of electrical equipment and components can also be terminated in production by resistance welding methods.

We welcome opportunities to discuss details and to work with you on your specific problems. All we need is an invitation.

WRITE FOR COMPLETE INFORMATION



THOMSON

ELECTRIC WELDER COMPANY

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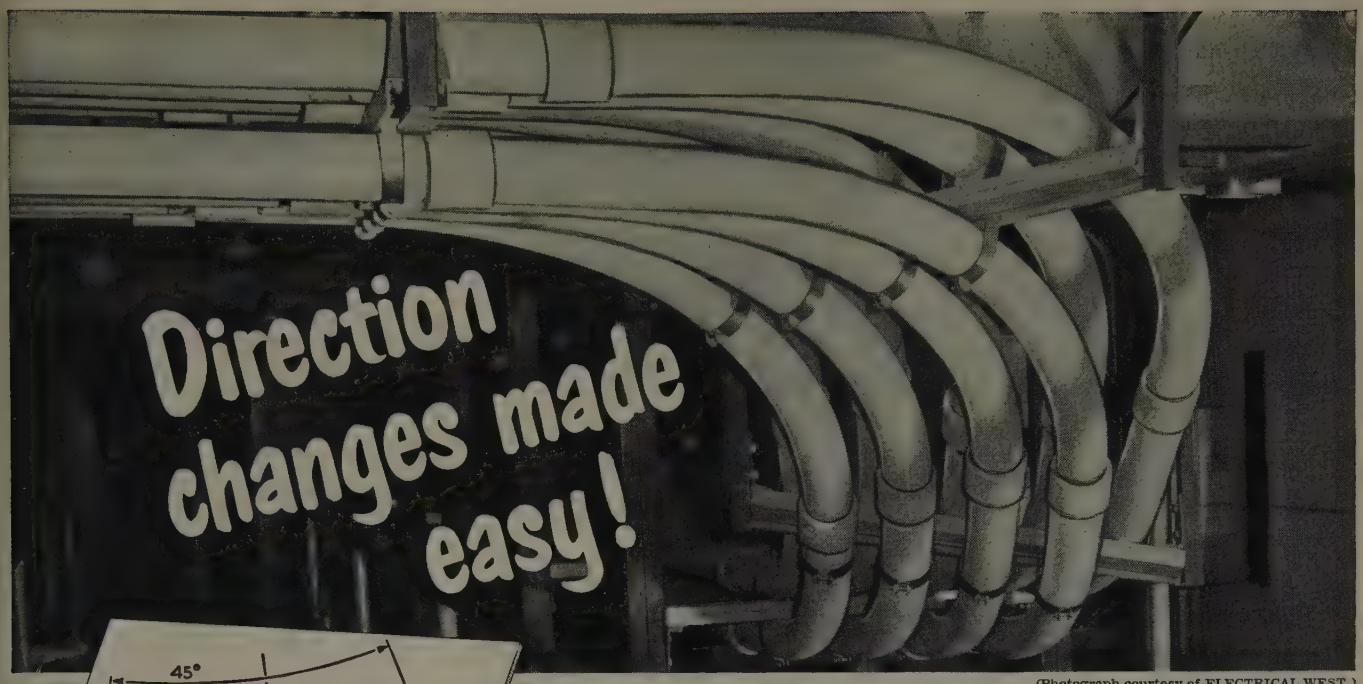
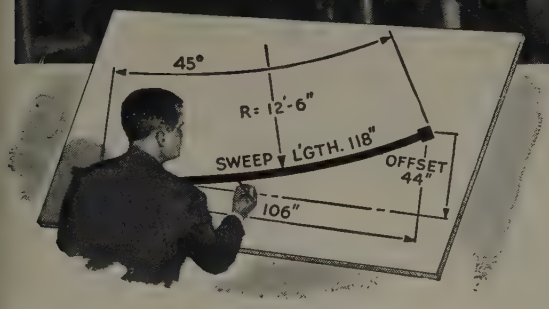
ELECTRIC THOMSON WELDERS



(Photograph courtesy of ELECTRICAL WEST.)



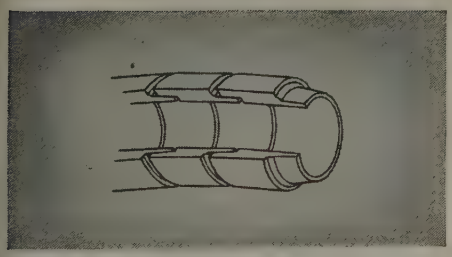
. . . with standard fittings for TRANSITE asbestos-cement DUCTS

When you use Transite Ducts, you have available a wide variety of standard fittings, made of the same asbestos-cement material as the ducts themselves. These fittings save time and expense because they provide maximum flexibility in laying out or constructing a duct system. They facilitate clearing unexpected obstructions or accommodating revisions in the original layout.

For instance, the new Transite 5° Bend Segments (shown at left) can be used alone to form simple and complex curvatures of any multiple of 5°. Used with other standard Transite curved fittings, they form curvatures of odd degrees. Thus, they enable you to simplify cross-overs and transformations . . . to clear obstructions . . . to form unusual or special bend or offset sections. They eliminate the need for purchasing special radii bends or sweeps.

The other standard Transite fittings that facilitate directional changes are the offset bends, standard 45° and 90° bends, sweeps, curved segments, laterals, tees, elbows and deflection couplings. These fittings are machined to a standard taper so that they can be used with Transite Conduit, Transite Korduct or with other Transite fittings.

For more information, write Johns-Manville, Box 60, New York 16, N. Y. In Canada, address 199 Bay Street, Toronto 1, Ontario.



5° bend segment sketched in detail. It consists of a straight section of Transite stock with a male taper on one end and a female taper on the other . . . each machined at an angle of 2½° to the center axis. Segments can thus be used single, or combined to form bend sections whose curvature is any multiple of 5°.

Photograph showing use of bend segments and curved segments with Transite Ducts.

5 OTHER REASONS WHY TRANSITE DUCTS DO A BETTER JOB AT LESS COST:

1. Corrosion-Resistant. Transite, being made of inorganic asbestos and cement, resists corrosion and is immune to electrolysis.

2. Permanently Smooth Bore. Transite makes long cable pulls easy, under any conditions. Danger of damage to cables is also minimized.

3. Incombustible. Transite will not burn or contribute to formation of smoke, gases, fumes. It confines burnouts, will not soften under heat.

4. Higher Thermal Conductivity. Cables run cooler in Transite, reducing I^2R losses, increasing current capacity and prolonging insulation life.

5. Easy to Install. Transite Ducts are light weight, easy to handle. Joints are quickly made. Long 10-foot lengths reduce number of joints in line.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville TRANSITE® DUCTS

TRANSITE KORDUCT—for installation in concrete

TRANSITE CONDUIT—for exposed work and installation underground without a concrete encasement

INDUSTRIAL NOTES . . . .

Honeywell Names Wishart to Managerial Post. The appointment of Paul B. Wishart to the newly created position of general manager of Minneapolis-Honeywell Regulator Company and his election to the board of directors was announced recently. He continues as vice-president. Mr. Wishart has been with Honeywell for 11 years and since 1945 has been vice-president in charge of manufacturing in the company's Minneapolis plants.

Cleland Joins Nuclear Research and Development. Marshall R. Cleland has joined the staff of Nuclear Research and Development, Inc., St. Louis, Mo., as a senior research physicist. Dr. Cleland has been associated with the Radiation Physics Laboratory, Betatron Section, National Bureau of Standards, as a research physicist for the past year and a half. Dr. Cleland will head several industrial research projects to be undertaken in the new laboratories just occupied by Nuclear Research and Development, Inc.

MacCarthy Named to Engineering Post at Westinghouse Columbus Plant. Parker W. MacCarthy has been made manager of the jet engine section, electric appliance engineering department, at the Westinghouse Electric Appliance Division plant, Columbus, Ohio. In his new post, Mr. MacCarthy will be responsible for transmitting design information to the factory for the manufacture of jet engine components. He was formerly in charge of compressor design for domestic refrigeration units at the division's East Springfield, Mass., plant.

Bendix Sales Appointments. Two new appointments to the sales force at Pacific Division, Bendix Aviation Corporation, North Hollywood, Calif., have been announced. John Calvin has been named hydraulic sales engineer. For the past 4 years he has been an assistant section head of the Research and Development Laboratories at Hughes Aircraft. Charles E. Ruckstuhl has been appointed electronic sales engineer. He was formerly associated with the Bendix International Division, covering South American markets.

Karl-Douglas Associates Appoints Ransom. David H. Ransom, formerly director of research at Bogue Electric Manufacturing Company in New Jersey, has been appointed chief engineer of the Electronic Division of Karl-Douglas Associates, Hawthorne, Calif. In his new duties, he will direct the design and production of various electrical and electronic products.

General Electric Distributor in Florida. The Air Conditioning Division of General Electric Company has appointed Mechanical Contractors Supply, Inc., Winter Park, Fla., as their sole distributor covering the state of Florida and 14 Georgia counties along the northern Florida boundary. Paul J. Spellman, president of Mechanical Contractors Supply, Inc., has appointed George J. Collins as vice-president and general sales manager, whose duties will be to enlarge the present dealer organization covering the Florida territory.

Allis-Chalmers Establishes Akron Branch Office. The establishment of a new Akron, Ohio, branch of the Cleveland district office of Allis-Chalmers general machinery division under the management of Fred C. Timberman has been announced. The new office is located in the First National Tower in Akron. Mr. Timberman has been a sales representative in Allis-Chalmers Cleveland district office for more than 10 years. Announcement has been made also of the assignment of Donald W. Ganzhorn as representative in the Akron office.

Burndy Engineering Acquires New York Warehouse. As part of its expansion program, Burndy Engineering Company, Inc., Norwalk, Conn., has acquired an 18,000-square-foot warehouse at 134th Street and Willow Avenue in the Bronx, N. Y. To be called Central warehouse, this new structure will facilitate the handling and storage of parts and finished products.

Delta-Star Electric Merged into H. K. Porter Company. Delta-Star Electric Company has been merged into the parent company, H. K. Porter Company, Inc., and will operate as Delta-Star Electric Division. Policies, management, and operation of the new Delta-Star Electric Division will remain the same, with C. S. Beattie continuing as general manager of the division. Both Mr. Beattie and R. E. Anderson have been elected vice-presidents of H. K. Porter Company, Inc.

Roscoe Named Lincoln Electric Vice-President. J. S. Roscoe has been appointed executive vice-president in charge of business administration of the Lincoln Electric Company, Cleveland, Ohio. Mr. Roscoe has been with Lincoln since 1924.

New Chairman of Board for Beckman and Whitley. Joseph B. Rice, Jr., has become General Manager and Chairman of the Board of Beckman and Whitley, Inc., San Carlos, Calif., manufacturers of meteorological instruments, ballistics cameras, and special instrumentation. Mr. Rice was previously production manager of Beckman Instruments, Inc., South Pasadena, Calif.

Du Mont Appoints Mayers. Morris Mayers has been named special sales representative in the New York area for the Transmitter Division, Allen B. Du Mont Laboratories, Inc. Mr. Mayers has just completed a tour of active duty as a base operations officer with the Marines in Korea. Prior to his Korean service,

(*Continued on page 20A*)

(*Continued from page 18A*)

he was president of Display Lightin Company, Inc. Among Mr. Mayer Du Mont assignments will be the r sponsibility for servicing the educationa and industrial television market in th New York area.

G-E Control Department Appointment Two appointments in the General Electri Company's Control Department, Schenec tady, N. Y., have been announced Frederic H. Holt has been named manage of marketing and James W. Cooke manager of engineering. Mr. Holt ha been with the company since 1935 an Mr. Cooke since 1925.

High Vacuum Equipment Corporatio Organized. Announcement of the recen organizing of the High Vacuum Equip ment Corporation for the development design, and manufacture of high-vacuu equipment used in the fields of electronics metallurgy, plastics, and metals has bee made by Joseph B. Merrill, president an general manager of the company. Willia O. DiPietro is in charge of the engineerin and research activities; production an purchasing departments are directed b Walter W. Mueller and Rogers G. Welles and general counsel for the company i Gerhard Bleicken. Mr. Merrill, Mr DiPietro, and Mr. Mueller were formerl associated with National Research Cor poration, and Mr. Welles was formerl with Estabrook and Company. Item currently being manufactured by Hig Vacuum Equipment Corporation includ vacuum pumping systems, vacuum fur naces, vacuum metallizing units, vacuu impregnating units, diffusion pumps valves, and gauges. The general office and factory of the company are locate at 349 Lincoln Street, Hingham, Mass.

Chapman Named Sylvania Vice-Presi dent. Sylvania Electric Products, Inc announced recently the appointment o Arthur L. Chapman to the newly create post of vice-president in charge of elec tronics operation. Mr. Chapman will b responsible for the operations of Sylvania' Radio and Television, Parts, Electronics Radio Tube, and Television Picture Tub divisions.

NEMA Standards for Silicone Varnishe Glass Fabric. This publication covers sili cone varnished glass fabric in sheet form full-width rolls and tapes to be used a electrical insulation between metal parts i electric apparatus. It includes orderin information, methods of test, dimensions physical and electrical properties, manu facture, packing, and marking. 12 pages 75¢. Order from National Electrical Manu facturers Association, 155 East 44th Street New York 17, N. Y.

Expanded Facilities for Nylon Pro duction. Approval of plans for the expan sion of facilities to increase the manufactur

(*Continued on page 34A*)

SAVE WITH ALUMINUM CONDUCTOR

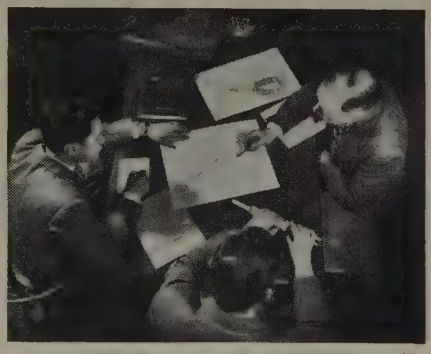
INITIAL SAVINGS—You *automatically* effect major savings when you specify aluminum conductor, because aluminum costs less than copper. Handling is easier because aluminum with equal conductivity is only about half the weight of copper.

INSTALLATION SAVINGS—Light weight aluminum conductor is easier to carry, easier to string, easier to move around. This results in faster, lower cost installations. Your *total average savings* with aluminum conductor can be as much as 25%.

SAVE MORE

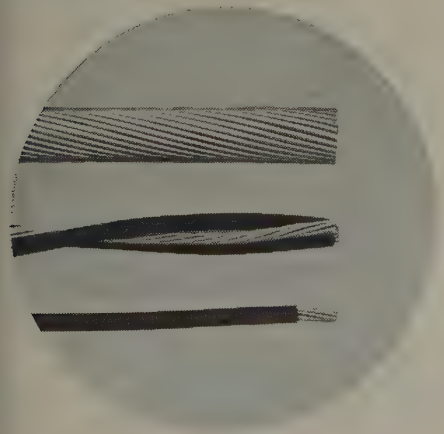
WITH KAISER ALUMINUM CONDUCTOR

KAISER ALUMINUM FIELD ENGINEERS work right on the job alongside crews, give stringing assistance, suggest ways to cut costs all down the line. They keep tabs on customer schedules—help maintain Kaiser Aluminum's unsurpassed record for *on-time delivery*.



KAISER ALUMINUM SERVICE ENGINEERS make detailed studies of customer's *individual problems* with an eye to greater economies. They help coordinate specifications and designs. They conduct meetings with crews, provide sag and tension charts on request.

KAISER ALUMINUM LABORATORY SERVICE assists customers on problems requiring fundamental research—often resulting in worthwhile savings. It's one of the industry's best-equipped and staffed laboratories, backed by Kaiser Aluminum's fully-integrated facilities.



THIS COMPLETE SERVICE is available to you at no obligation when you specify Kaiser Aluminum conductor. *Act now!* A letter or telephone call is all that's required. Also request free pamphlet giving complete engineering data on new Kaiser Aluminum covered conductor—both weatherproof line wire and self-supporting Triplex cable for service drops and secondary distribution lines. Contact any Kaiser Aluminum office in principal cities, or one of our many conductor distributors. Kaiser Aluminum & Chemical Sales, Inc., Oakland 12, California.

Kaiser Aluminum

setting the pace—in growth, quality and service

NEOPRENE AND POLYETHYLENE COVERED CONDUCTOR, SOLID AND STRANDED • SELF-SUPPORTING TRIPLEX CABLE • ACSR • ALL ALUMINUM CONDUCTOR

(*Continued from page 20A*)

of continuous filament nylon yarn at the Du Pont nylon plant in Chattanooga, Tenn., has been announced. As soon as design work is completed, construction work will start, perhaps by late spring of 1953, and will be finished sometime in 1955. Cost of the expansion program may exceed $9,000,000.

Bendix Aviation Starts Division on Pacific Coast. Formation of the Bendix Computer Division of the Bendix Aviation Corporation with headquarters at Hawthorne, Calif., has been announced. Palmer Nicholls will be general manager of the division.

NEW PRODUCTS • •

Self-Affixing Neoprene Tape. Bi-Prene, a self-affixing neoprene electrical insulating tape, has been announced by the Bishop Manufacturing Corporation, Cedar Grove, N. J. This easy-to-apply tape provides a splicing medium with a high degree of oil and solvent resistance, when vulcanized, plus outstanding dielectric strength and aging qualities. Bi-Prene conforms to irregular surfaces when wrapped under normal taping tension, and may be cured in a field or factory patching press to produce a smooth splice. The curing time is directly related to the depth of the splice and the mold temperature. In most applications, the curing process can be accomplished in a matter of minutes, and at temperatures not exceeding 310 degrees Fahrenheit. For additional details or specific application data, please address inquiries to Bishop Manufacturing Corporation, 58 Factory Street, Cedar Grove, N. J.

Relay in New Miniature Enclosure. Bantam-sized Class "S" relays manufactured by Automatic Electric are now available in a new small hermetically sealed enclosure. The entire unit measures $2^{1}/_{32}$, by $^{31}/_{32}$, by $1^{1}/_{2}$ inches and weighs only $1^{7}/_{8}$ ounces. This miniature relay was designed for minimum inductance and maximum make-and-break speeds. It is tamperproof and atmosphere-protected. This relay in its new enclosure is recommended by the manufacturer for applications wherever extremes of shock, temperature, and vibration require exceptional performance. Complete information is available by writing Automatic Electric Sales Corporation, 1033 West Van Buren Street, Chicago 7, Ill.

New Automobile Storage Battery. An entirely new kind of automobile storage battery — one fitted with recently invented catalyst filler caps that eliminate loss of battery fluid — is being introduced by Hester Battery Manufacturing Company and is manufactured and distributed under the name of Hester Gold Medal battery. Such components as Fiberglas separator and multiplate cells together with the

(*Continued on page 38A*)

Allis-Chalmers distribution regulator in a Minnesota distribution system.

Now you can solve voltage problems fast. Stocks of Allis-Chalmers power and distribution regulators located at 20 strategic points across the country assure fast, efficient delivery when you have voltage troubles. You can end complaints due to low voltage economically and start profits rising faster than ever before.

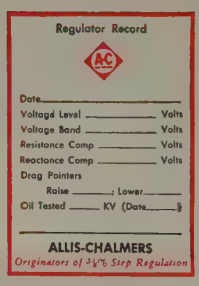
Allis-Chalmers 5/8% step voltage regulators have proved themselves in the twenty years since they were first introduced. They are low in cost. They are accurate and reliable. And now with the new stocking program, they are the fast answer to voltage problems as well.

Get Full Information

Get the full story on Allis-Chalmers power and distribution regulators. Call your nearest Allis-Chalmers district office today or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3933

FREE MAINTENANCE STICKERS PROVIDE HANDY SERVICE RECORD

You get an on-the-spot record of control settings with these handy, adhesive-backed stickers. They go on any type of regulator, giving all the room you need for a complete service record. Write on them in pen or pencil. Call your nearest A-C district office or write Allis-Chalmers, Milwaukee 1, Wisconsin.



ALLIS-CHALMERS

A-C ALLIS-CHALMERS

Originators of 5/8% Step Regulation

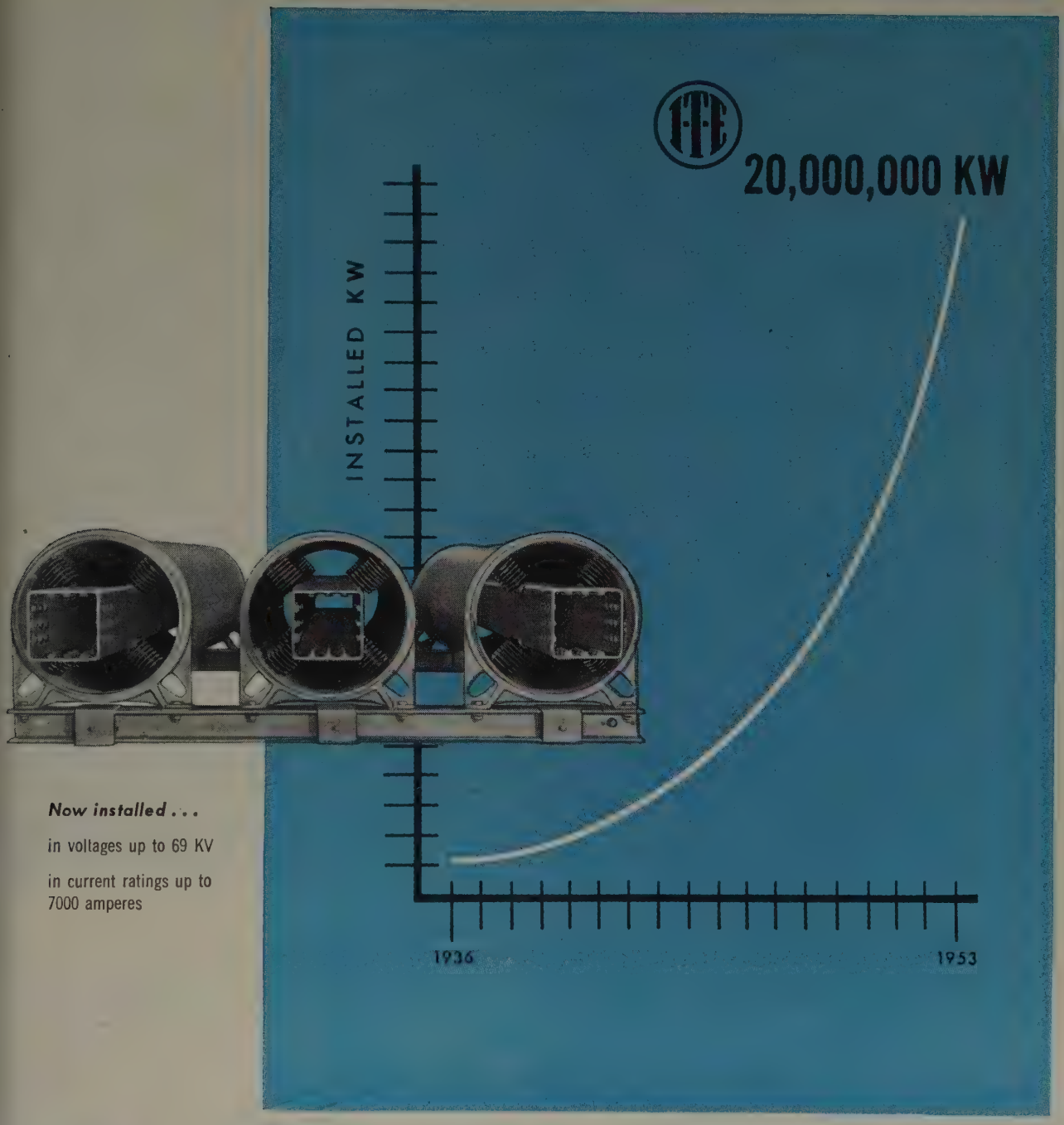
(*Continued from page 34A*)

catalyst caps combine to provide a premium battery. The unique battery caps mak the water in the battery last over seve times longer than normal by convertin the escaping hydrogen and oxygen gase back into water. They also give a indication of battery overcharge by heat ing to a point hot to the touch (beyon 200 degrees) when the battery is receivin a destructive amount of current from th generator. Under proper charging condi tions the caps operate warm to the touch The caps also give an indication of a dea cell since the cap on such a cell will remai cold, while the others will be exceptionall hot. In addition the new caps preven corrosion of battery posts, terminals, an other underhood parts by condensing an returning the corrosive sulfuric acid fume which commonly escape from the battery The caps contain small pellets coated wit palladium, which has the power of causin catalytic action. The pellets are sus pended in a nickel-plated bronze scree cage in the top of the cap. The Gol Medal battery operates with a low con centration of sulfuric acid, working wit a specific gravity of 1,250. The ne Gold Medal batteries are available wit either 51 or 57 heavy duty plates, and hav a 110- or 120-ampere-hour rating, depend ing on the make of the car. Fibergla separators, used throughout, hold the activ lead oxide material in place much longe than do conventional wood separators Fiberglas separators are unaffected b sulfuric acid battery fluid and will no warp under high temperatures. The cas is made of hard rubber and is specially designed to resist road shocks and vibra tion.

Precipitron Oil-Mist Control Unit. A completely redesigned precipitron oil mist control unit that will recover th coolant oil from the mist and smok generated by high-speed cutting, grinding milling, and similar machining operation is available from Westinghouse. Thi redesigned oil-mist control unit is availabl in two models: Type *PO-6* and *PO-12 PO-6* has an air-handling capacity o 600 cubic feet a minute; *PO-12* of 1,20 cubic feet a minute. The precipitron oil mist control unit is completely self contained. The heavy gauge sheet stee cabinet houses the all-aluminum oil particle charging and collecting element with their high-voltage power pack; th motor-driven fan; duct connection; an oil sump. The fan motors are 3 phase fractional horsepower, ball bearing, pre lubricated, totally enclosed, for 220- o 440-volt service. The power pack operate from a single-phase 115-volt line and con sumes less than 60 watts when operating For further information, write Westing house Sturtevant Division, Departmen T-509, 200 Readville Street, Hyde Park Boston, Mass.

RCA Tubes. The Radio Corporation o America has announced the availability o the following tube types. The *5718* is medium-mu subminiature triode designe

(*Continued on page 46A*)



Now installed . . .

in voltages up to 69 KV

in current ratings up to 7000 amperes

ISOLATED PHASE BUS

I-T-E CIRCUIT BREAKER COMPANY • 19th & Hamilton Sts., Philadelphia 30, Pa.

R&IE EQUIPMENT DIVISION, Greensburg, Pa.

(*Continued from page 38A*)

especially for use as a radio-frequency power amplifier and oscillator in ultra-high-frequency applications where dependable performance under shock and vibration is a prime consideration. It is capable of giving a useful power output of nearly 1 watt at 500 megacycles. Operation with full input is permissible up to 1,000 megacycles. Featured in the *5718* is high transconductance, a pure-tungsten heater to give long life under conditions of frequent on-off switching, and a compact design in which special attention has been given to structural details that provide increased mount strength to resist shock and vibration.

The *6211* is a new medium-mu twin triode of the 9-pin miniature type designed for frequency-divider circuits in electronic computers and other on-off control applications involving long periods of operation under cutoff conditions. For such control service, the *6211* maintains its emission capabilities even after long periods of operation under cutoff conditions and therefore provides good consistency of plate current during its on cycles. The *6211* has separate terminals for each cathode to facilitate flexibility of circuit arrangement, and a mid-tapped heater to permit operation from either a 6.3-volt or 12.6-volt supply. The heater is made of pure tungsten to give long life under conditions of frequent on-off switching.

A premium version of the miniature sharp cutoff pentode *6AK5*, the *5654* is designed for use as a broad-band radio-frequency or intermediate-frequency amplifier in mobile and aircraft receivers. Featured in the *5654* is a compact structure specially designed to provide increased mount strength against shock and against vibration, and a pure-tungsten heater to give long life under conditions of on-off switching. The *5654* has high transconductance, low interelectrode capacitances, high input resistance, and high signal-to-noise radio.

Full-Wave Rectifier Tube. National Electronics, Inc., Geneva, Ill., have announced a new high-current full-wave rectifier. This tube, designated as the *NL-606*, carries 6.4 amperes direct current, and 25.6 amperes peak rating. It was designed especially for industrial power rectifier applications requiring higher voltages up to 900 volts peak inverse or 250 volts direct current. *NL-606* is gas and mercury filled for quick starting, long life, and high peak inverse within wide temperature limits. Other ratings are filament voltage, 2.5 volts, filament current, 17 amperes; and peak inverse voltage, 900 volts.

Decade Inductance Units. Torocoil Company has announced the introduction of a complete line of decade-type inductance units. These units include the four popular ranges from 1 millihenry to 10 henrys and are available as single units which can be connected together to give an inductance change of as little a

(*Continued on page 52A*)

Helipot

come to Helipot *for the largest selection of* single turn *precision potentiometers*

The same engineering know-how and precision manufacturing facilities that have made HELIPOT the world's largest manufacturer of multi-turn potentiometers, have also established its leadership in the design and production of high precision *single*-turn potentiometers. These single-turn units are built with the same infinite care . . . on the same types of specially-designed equipment . . . by the same highly trained personnel that have made Helipot multi-turn potentiometers the world's standard. *Result*—a wide selection of single-turn potentiometers, available in volume, built to the highest-possible standards—*at mass-production economies!*

Most of the units shown at right are readily adaptable to special requirements—servo mountings, ball or sleeve bearings, ganged assemblies, single or double shaft extensions, taps spot-welded to a *single* turn of winding at virtually any desired point, and many other optional features to meet the needs of *your* applications.

So, no matter what your requirement in precision potentiometers, bring it to Helipot!

ADVANCED ENGINEERING! VOLUME PRODUCTION!

MODEL L SERIES (3" DIA.):
A high-precision single-turn unit with continuous mechanical rotation and minimum electrical dead space. Model L has bushing mounting, sleeve bearings . . . LS, servo mounting, sleeve bearings . . . LSP servo mounting, ball bearings. All are gangable to 8 sections, sections phaseable after assembly to within ±1°. Many other features.*

MODEL J (2" DIA.):
The first production designed potentiometer with ball bearings as a standard feature—also versatile three-way servo mounting. Individual sections can be easily ganged and independently phased by the user after installation without external brackets or clamps. Many other unique features.*

MODEL G (1 5/16" DIA.):
A compact, single-turn precision potentiometer—low in price, extra rugged. Developed initially for remote positioning and indicating in aircraft applicatons—now also used for general instrumentation and servo mechanisms. Continuous 360° rotation. In certain resistance values is excellent for high temperature applications—at ambient temperatures as high as 165°C. under certain conditions.*

miniature

MODEL T "TINYTORQUE" (7/8" DIA.):
A miniature ultra-low-torque unit for guided missiles and aviation electronics. Features shielded ball bearings, highest possible precision and quality, long life, rugged dependability. Length only 25/32"—weight only 0.56 oz.—starting torque only 0.005 oz. in., when specified—negligible running torque. Sliders phaseable to within 3°. On vibration tests units have successfully withstood frequencies 0 to 2000 c.p.s. in 3 planes, accelerations up to 20 G's for periods to 1 hr.*

See your nearest Helipot Representative for complete details. Or write direct!

Duodials *for every application*

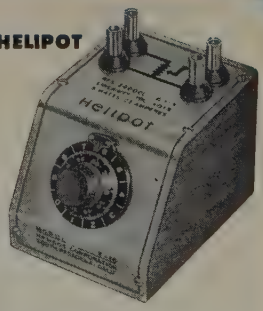
Duodial turn-indicating knob-dials are ideal for Helipots and other multi-turn applications. Available in a wide range of sizes and turns ratios . . .

MODEL RA:
The beautiful new 10 turn *Precision Duodial* with a "feel" and appearance that add distinction to the finest instrument panels. Features excellent readability, positive locking lever, easy assembly. Available in 10:1 ratio only.

MODEL R:
Standard 2" Duodial in 10:1, 15:1, 25:1, 40:1 turns ratios for various Helipot ranges. Locking device, if desired.

MODEL W:
Large 4¾" Duodial for primary control applications. Easy to adjust and read. Finger hole for rapid rotation. Available in turns ratios of 10:1, 15:1, 25:1, 40:1.

THE LABORATORY HELIPOT (MODEL T-10):



A 10 turn Helipot, "R" Duodial and 3-way binding posts combined in a handsome walnut-cased unit ideal for laboratory and instruction purposes. Simplifies making and changing experimental circuits. More compact and 5 times faster to set than decade boxes. Linearity 0.1%, Power Rating 5 watts, Standard Resistance Ranges 100 to 100,000 ohms—others on order.

THE Helipot CORPORATION
SOUTH PASADENA 9, CALIFORNIA

Field Offices: Boston (CO. 7-1961), New York (Rockville Center 6-1014), Philadelphia (COllingswood 5-3515), Rochester (CU. 7640), Schenectady (DE. 2319), Cleveland (PR. 1552), Detroit (TO. 8-3130), Chicago (PA. 5-1170), St. Louis (SW. 5584), Los Angeles (RY. 1-8345), Seattle (FR. 7515), Dallas (ST. 3335), High Point, N. C. (3672) and Ft. Myers, Fla. (FO. 1269-M). Canada: J. S. Root, Toronto (OR 3003). Export Agents:

(*Continued from page 46A*)

1 millihenry in 10,000. These inductor are wound on the highest quality toroidall shaped powdered molybdenum permallo cores. Quality factors as high as 250 ar obtainable with these units. Switching i performed by the use of high curren capacity, low resistance, instrument-typ switches. For further information writ directly to Torocoil Company, 1374 Mobil Court, St. Louis 10, Mo.

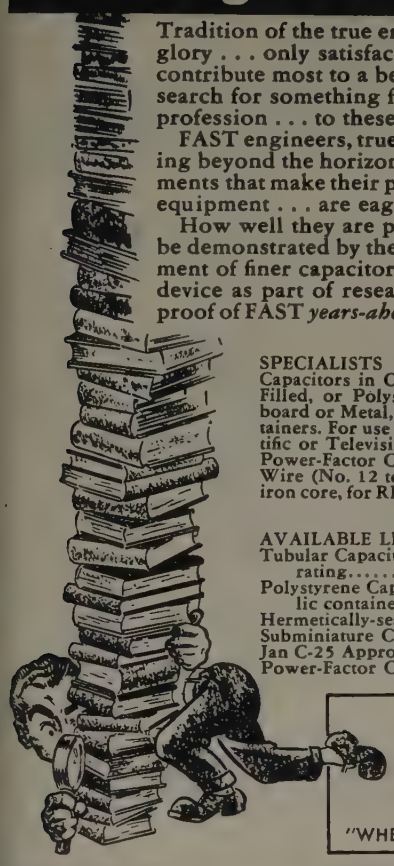
Magnetic Heads. The first new member of the new line of Brush Magnetic Head are now in production. One is a record reproduce head, *BK-1090;* the other, it erase head companion, is a *BK-1110* The *BK-1090* is intended for dual trac recording and distinguishes itself by ver high resolution and uniformity. The mos outstanding feature of the *BK-1110* is it low power consumption of less than 1/ volt-ampere. These units are cast into block of specially selected synthetic resi which makes them extremely uniform moistureproof, nonmicrophonic, and allow operation throughout a wide temperatur range. The low-loss core structure i made from thin molybdenum permallo laminations carefully annealed and ce mented together permitting the use c high bias and erase frequencies. Thes components are enclosed in a mu magneti shield to provide optimum shielding fron extraneous magnetic fields. The fre quency response obtained from the combi nation of Brush heads and a magneti medium is smooth and free of discon tinuities. Shape of the head permits clos mounting of adjacent heads and provide correct approach angle of the tape.

Miniature Vertical Deflection Amplifier A miniature, high perveance, double triode vertical deflection amplifier is now i production at the Radio Tube Divisio of Sylvania Electric Products, Inc., Em porium, Pa. The tube has been desig nated type *12BH7*. The unit consists c two completely independent medium-m triodes in a T-6 1/2 envelope. One sectio may be used as the sawtooth generato while the other section serves as the vertica deflection amplifier. Both sections ar designed to withstand the high puls voltages normally encountered in vertica amplifier service. For certain applica tions where the plate supply voltage mus be kept low, parallel connection of th two sections may be used. The heater c the Sylvania type *12BH7* is designed t operate from either 6.3 or 12.6 volts.

Very-High-Frequency – Ultrahigh - Fre quency Capacitor. A very-high-fre quency – ultrahigh - frequency capacito specifically designed for use in tune circuits that operate at frequencies fro 50 megacycles to 500 megacycles being introduced by the Hammarlun Manufacturing Company. The capacito the *VU,* incorporates a unique desig which places two capacitor sections i series and eliminates the need for contac to the rotor. The rotor is complete

(*Continued on page 54A*)

Getting to the bottom of things



Tradition of the true engineer and scientist . . . no thought of personal glory . . . only satisfaction in the development of those things which contribute most to a better civilization . . . tireless in his never-ending search for something finer . . . such is the heritage of the engineering profession . . . to these we owe much.

FAST engineers, true to their profession . . . forward looking; searching beyond the horizon and planning ahead; ever seeking those refinements that make their product better to fit the needs of TOMORROW'S equipment . . . are eager to help you plan for the new day just ahead.

How well they are prepared to cope with tomorrow's problem can be demonstrated by their use of X-Ray as an instrument in the development of finer capacitors . . . 1935* found them applying this scientific device as part of research and manufacturing procedure . . . another proof of FAST *years-ahead investigation and getting to the bottom of things.*

SPECIALISTS IN: Fixed Paper Dielectric Capacitors in Oil or Wax; Impregnated and Filled, or Polystyrene Film Units. In Cardboard or Metal, Rectangular or Tubular Containers. For use in Electrical, Radionic, Scientific or Television Equipment.
Power-Factor Correction Capacitors, Heavy-Wire (No. 12 to No. 20) Choke Coils, air or iron core, for RF or Radio Noise-Suppression.

**See HERMAN E. SEEMANN, PHYSICIST, KODAK RESEARCH LABORATORIES, "Miscellaneous Applications of Radiography and Fluoroscopy," Symposium on Radiography and X-Ray Diffraction Methods, American Society for Testing Materials, Philadelphia, Pa.* (1937).

AVAILABLE LITERATURE:
Tubular Capacitors in paper tubes. 65° or 85°C rating..... SEC. I, CATALOG 25
Polystyrene Capacitors in paper tubes or metallic containers..... SEC. IV, CATALOG 25
Hermetically-sealed Tubular Capacitors..... SEC. VI, CATALOG 25
Subminiature Capacitors: Special Bulletin.
Jan C-25 Approved Capacitors: refer to Jan C-25, "Specifications"
Power-Factor Correction Capacitors SECS. I, II, III, IV, CATALOG 27

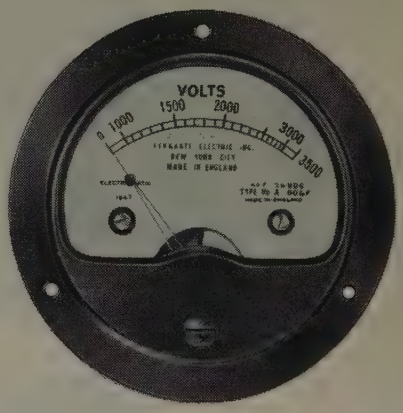
JOHN E. FAST & CO.
Capacitor Specialists for Over A Third of A Century
3169 North Pulaski Road, Chicago 41, Ill.
"WHEN YOU THINK OF CAPACITORS . . . THINK FAST"

ALWAYS . . . "on the beam" with *Standard Piezo* CRYSTALS

If it is important for your transmitting and receiving equipment to stay "on the beam"—always, regardless of atmospheric extremes and rough handling—be sure to specify Standard Piezo Crystals. They're built to take it. Send for our completely illustrated catalog or submit your problems to our engineers for recommendations.

Standard Piezo Co.
CARLISLE, PENNA

A TRUE ELECTROSTATIC VOLTMETER



This instrument permits voltage readings on AC or DC circuits of very high resistance. The only current drawn is the very small leakage current and a very low capacitance current on AC circuits. Very useful for the many high voltage—low current circuits employed in nuclear research. Available with full scale voltages ranging between 300 and 3500 volts. Special laboratory instrument available with full scale reading of 150 volts. Full scale capacitance ranges from 8 mmfds for the 3500 volt model to 100 mmfds for the 150 volt instrument. Magnetic damping. 2½" dial. Write for complete specifications.

FERRANTI

FERRANTI ELECTRIC, INC.
30 Rockefeller Plaza • New York 20, N. Y.
FERRANTI, LTD., Hollinwood, England
FERRANTI ELECTRIC, LTD., Toronto, Canada

(*Continued from page 52A*)

isolated by the use of Pyrex glass ba bearings. As a result of this constructio contact and bearing noise is eliminate completely. The series design also permi a more symmetrical design of the capacito itself and consequently allows better circu layout.

Capacity-Resistance-Inductance Bridge The new Clough-Brengle Model *71* capacity-resistance-inductance bridge used to measure the capacitance of pape mica, electrolytic, ceramic, and air ca pacitors; the stray capacitance of bushing switches, and wiring; the dissipatio factor of capacitances; the leakage curren of electrolytic capacitors; the resistanc of composition and wire-wound resistors the inductances of coils and transformers the storage factor (Q) of inductances the turns ratio of transformers; the insula tion resistance of capacitors, bushings, an barriers; and the quality of capacitor already wired into a circuit. Model *71* has good accuracy and is small in siz and light in weight. For informatio write to the Clough-Brengle Company Department EZ, 6014 Broadway, Chicag 40, Ill.

Germanium Rectifiers. The Genera Electric Company has announced ne diffused junction germanium rectifiers fo use in computers, magnetic amplifiers television receivers, and telephone switch boards. The new series includes fou models, *4JA1A1*, *4JA1A2*, *4JA1A3*, an *4JA2A4*. They are hermetically seale and extremely small in size. Forwar resistance of the new units is very low, les than 2 ohms at rated load. Back re sistance and peak inverse voltages ar high. Glass-to-metal seals are used t seal the units hermetically against de teriorating elements. The rectifiers mee stringent humidity, shock, and vibratio requirements. Peak inverse voltages rang from 100 to 400 volts. D-c output into resistive load ranges from 75 to 500 milli amperes. Full-load voltage drop is 0. in three models and 0.7 in the fourth. A ratings are at ambient temperatures up t 55 degrees centigrade. Further informa tion on the new germanium rectifiers i available from Department N-13, Inquir Section, General Electric Electronics Divi sion, Electronics Park, Syracuse, N. Y.

TRADE LITERATUR

Transformers for Air-borne Rada Equipment. Featuring typical example of specialty transformers for air-born electronic equipment, a brochure, complet with illustrations and descriptions, ha been issued by Goslin Electric and Manu facturing Company, a division of Th Goslin Corporation, Burbank, Calif. Th brochure outlines applications of trans formers custom-engineered especially fo air-borne radar, gyro, and communica tions equipment, and describes construc

(*Continued on page 56A*)

JUST OFF THE PRESS--

and yours for the asking!

3rd edition of

LOCKE'S RM* HANDYLOG of insulators and pole line hardware

This new revised edition lists . . . in 72 pages . . . ALL the pole line hardware, as well as ALL the power insulators and suspension hardware you need for handling over 95% of your jobs. Mail coupon today for your free copy. Place the RM* items on your standards list . . . and you'll benefit five ways:

***RM (Repetitive Manufacture)**
A program designed to help reduce the installed cost per kilowatt on line and station equipment.

1. **YOU SIMPLIFY** stocks and stocking operations.
2. **YOU PAY LOWEST PRICES** because RM items are standard items . . . produced in large quantities.
3. **YOU GET PROMPT SERVICE** because RM items are carried in stock by Locke Regional and Distributors' warehouses.
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5. **YOU REDUCE CHANCES OF OBSOLESCENCE** because assured availability of RM items allows you to match future extensions to present construction.

LOCKE
LOCKE DEPARTMENT
GENERAL ELECTRIC COMPANY
BALTIMORE, MARYLAND

MAIL THIS COUPON TODAY

LOCKE DEPARTMENT—GENERAL ELECTRIC COMPANY
BALTIMORE, MARYLAND

Please send me my copy of Locke's new RM* Handylog.

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

Before you buy **stop!** **See what Locke's Got!**

(*Continued from page 54A*)

tion features, electrical characteristics dimensions, weights, and specifications The brochure can be obtained by writing to Department AT, Goslin Electric and Manufacturing Company, 2121 West Olive Street, Burbank, Calif.

Precision Control Systems. A 12-page guide to precision automatic control components has been issued by the Transicoil Corporation, 107 Grand Street, New York 13, N. Y. Included are numerous photographs and diagrams of control components as well as full descriptions of basic Transicoil control motors, motor-driven inductions generators, miniature gear trains, servo amplifiers, and combination units, all of which are electrically and mechanically adaptable to match automatic control requirements precisely. Copies of this Transicoil Bulletin *MC1* are available on letterhead request to the manufacturer.

Electric Equipment for Chemical Processing. A 15-page booklet that catalogues and describes electric equipment for chemical processing is available from the Westinghouse Electric Corporation. Divided into three main sections, power generation distribution, and utilization the booklet illustrates and explains the function of electric equipment as varied as turbine-generators and bus duct. Apparatus such as power centers, rectifiers chemical motors and controls, and adjustable-speed drives are covered, giving the standout characteristics and advantages of each to the chemical processing industry Where applicable, circuit diagrams, ratings, and installation pictures are presented. For a copy of this booklet, *B 5656*, write Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa.

Machine Tool Catalogue. Specifications of all lathes, shapers, drill presses, attachments, chucks, tools, and accessories are contained in a new 88-page catalogue *5205*, released by South Bend Lathe Company. Several of South Bend's latest machine tool developments are featured for the first time. These include a new type of pedestal tool grinder plus many tools and attachments for South Bend lathes, drill presses, and shapers. Copies may be had from any South Bend distributor or by writing directly to South Bend Lathe Works, 425 East Madison Street, South Bend 22, Ind.

Null System of Measurement. The Ohmart Corporation offers, with the introduction of the Ohmart Densit Gauges, a simple, direct method of measuring many unusual process variables, where density is a function of the measurement desired. The penetration power of radioactivity is employed in the new system to make possible measurements heretofore considered impractical or impossible because of such conditions as high temperatures or pressures, or corrosive or erosive elements. Liquid level and interface liquid level, surface films, specific gravity

(*Continued on page 58A*)

BIDDLE
Instrument News

- ELECTRICAL TESTING INSTRUMENTS
- SPEED MEASURING INSTRUMENTS
- LABORATORY & SCIENTIFIC EQUIPMENT

JAMES G. BIDDLE CO., 1316 ARCH ST., PHILADELPHIA 7, PA.

BRIDGE-MEG®

SAVES THE COST OF TWO INSTRUMENTS

SAVES TESTING TIME

The Bridge-Meg is really two instruments in one. It combines a Wheatstone Bridge for measuring conductor resistance of coils, resistors and circuits, and a Megger direct reading ohmmeter for measuring electrical insulation resistance. A Varley Loop feature for locating faults on wires may also be included. The combined, compact instrument weighs about 15 lbs.

Practically everything you need is provided in the Bridge-Meg for electrical resistance measurements from a fraction of an ohm up to 1000 megohms. A multi-position rotary switch changes internal connections between insulation resistance tests, Wheatstone Bridge and the Varley Loop connection. Scale reads directly in ohms and megohms.

The Bridge-Meg requires no batteries or outside source of current. Test current is supplied by a hand-cranked generator. Its constant-voltage mechanism eliminates the "human element" in the speed of turning the crank.

Available complete with carrying case and test record cards in a standard selection of 5 ohmmeter scales.
Write for 12-page **Bulletin 21-60-EE.**

MEASURES ELECTRICAL RESISTANCE AS LOW AS 10 MICROHMS

Megger® Portable Low Resistance Ohmmeters

Self contained battery-operated and rectifier-operated types of Megger Low Resistance Ohmmeters have just been developed. They are designed for hard routine and emergency service in measuring contact resistance, such as in circuit breakers, relays, switches, bonds, connections and joints, commutator bar-to-bar tests and the like.

These portable instruments (weight 19 lbs.), are designed for low resistance measurements in the shop and in the field. They are of moderate cost and are accurate to within 1.5% of full scale deflection.

Model 1B operates from two 4 FH dry cells mounted inside the case.

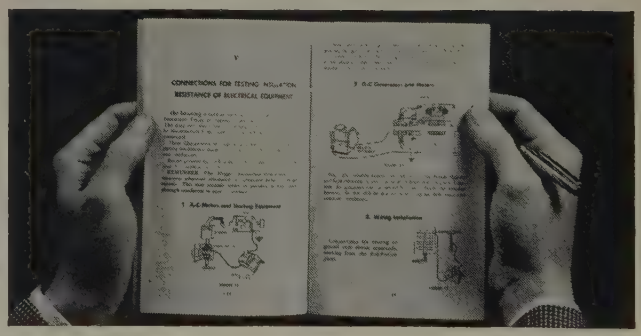
Model 1R operates from a rectifier, built inside the instrument case, for connecting to 115 volts, 50-60 cycles.

These new instruments operate on the same crossed-coil ohmmeter principle as the Ducter Low-Resistance Ohmmeter, with pointer indications of resistance and no necessity for balancing or voltage adjustment. Anyone can operate this equipment — no special training or experience is required.

Write for **Bulletin 24-46-EE.**

MEGGER® MANUAL

tells you how to test ELECTRICAL INSULATION



This 94 page manual is in demand by educators as well as practical electrical men. It covers subjects of necessity to anyone who is responsible for electrical equipment.

"Why Test Insulation Resistance?"
"Preparation of Apparatus for Test"
"Tests When Drying Out Wet Apparatus"
"Temperature Correction"
"Methods and Interpretation"

These are but a few of the 14 chapters that are built around the subject of testing electrical insulation resistance . . . and, of course, effective use of the Megger® Electrical Insulation Resistance Tester sold in the U. S. only by the James G. Biddle Co. Supply is limited. Please write on your company letterhead for **INSTRUCTION MANUAL 21-J-EE.**

JAMES G. BIDDLE CO. B825
1316 Arch St., Philadelphia 7, Pa.

Please mail me

☐ Bulletin 21-60-EE ☐ Bulletin 24-46-EE ☐ Bulletin 21-J-EE

*Name*_____

*Job*_____

*Company*_____

*Address*_____

(*Continued from page 56A*)

unit weight per unit area, gas or liquid composition are a few of the variables that can be measured with accuracy and sensitivity by this new Null System of measurement. Basis for the new Density Gauge is the Ohmart Cell, in which radioactive energy is converted directly into electric energy, thus eliminating any need for a high-voltage power supply. Detailed information is contained in Ohmart Bulletin *10414*, available upon request from The Ohmart Corporation, 2347 Ferguson Road, Cincinnati 38, Ohio.

Service Parts Directory. A comprehensive, 142-page "Service Parts Directory," containing schematic diagrams, parts lists, and top and bottom chassis views for the 71 1950 and 1951 RCA Victor television receivers, has been announced by the Tube Department of RCA Victor. Designed for the convenience of television service dealers and technicians, the directory speeds and facilitates the selection of service parts. The directory is available now from RCA tube and parts distributors.

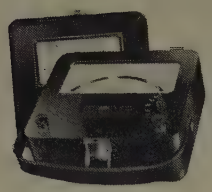
Metering Applications. A 20-page booklet describing metering applications for watt-hour meters has been announced as available from the General Electric Company, Schenectady, N. Y. Designated *GET-1905*, the new bulletin contains circuit wiring diagrams for the various metering applications. It also describes watt-hour-meter constants and register data, the determination of watts load and the use of watt-hour meters with instrument transformers.

D-C Solenoids. Cannon Electric Company has issued a new, revised catalogue covering the company's line of d-c solenoids. The 72-page bulletin shows 82 distinct types in 5 shell diameters and 25 different coil windings for intermittent and continuous duty. Photographs, dimensional sketches, sectional views, various types of charts are among the illustrations. The basic engineering data include duty cycle, rated voltage, stroke, current drain, ambient temperature, and tractive force of each type. For copies of the bulletin *DCS3-1952*, write Cannon Electric Catalogue Department, 420 West Avenue 33, Los Angeles 31, Calif.

Timing Relays. The Allen-Bradley Company is offering a 16-page bulletin featuring its complete line of timing relays. Fluid dashpot, pneumatic, and electronic timers are described fully. It also contains complete operation and engineering data. Applications are clearly stated. A selector chart is provided along with suggestions on the various factors to consider in choosing a timing relay for a particular application. A request to the Allen-Bradley Company, Milwaukee, Wis., will be filled promptly.

Porcelain Insulators. Publication of a 36-page boolket on the manufacture

(*Continued on page 60A*)



Model 622—Ultra-Sensitive Instruments

Portable d-c and a-c thermo instruments for precision measurement of potentials and minute currents in electronics or laboratory research.

Specialized and Multi-purpose

INSTRUMENTS

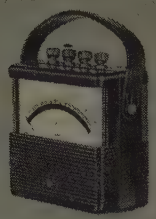
for

- **RESEARCH**
- **PRODUCTION**
- **MAINTENANCE**

For complex, or just routine measurement jobs, these and other specialized WESTON Instruments save time and assure dependable measurements. For information on the complete line, see your local Weston representative, or write . . . WESTON Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

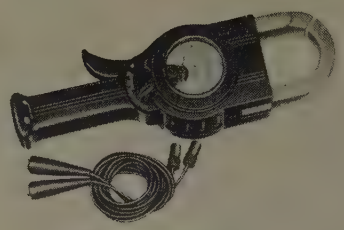
WESTON

Instruments



Model 901
Portable Test Instruments

Available in d-c, Model 901—and a-c, Model 904, single and multiple ranges of wide coverage. Excellent scale readability and shielding. Accuracy within ½ of 1%.

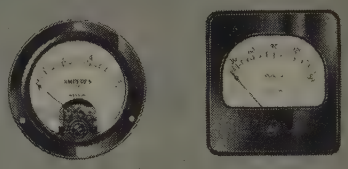


A-C Clamp Volt-Ammeter

(Model 633, Type VA-1) For convenient and rapid measurement of a-c voltage and current without breaking the circuit. Jaws take insulated or non-insulated conductors up to 2" diameter. Safe, rugged, versatile. Also available as a-c clamp ammeter, without voltage ranges.

Sensitive Relays

A line of sensitive relays including the Model 705 which provides positive operation at levels as low as ½ microampere. Non-chattering magnetic contacts handle up to 10 watts at 120 volts.

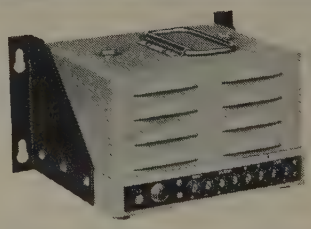


Panel and Switchboard Instruments

A complete line of instruments in all types, sizes and ranges required for switchboard and panel needs . . . including d-c, a-c power frequencies and radio frequency, rectifier types and D.B. meters.

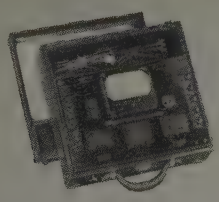
Model 697 Volt-Ohm-Milliammeter

One of a line of pocket-size meters, Model 697 combines a selection of a-c and d-c current, and resistance ranges. Ideal for maintenance testing and many inspection requirements.



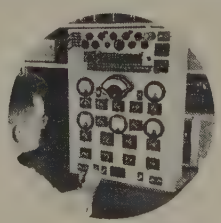
Model 1411 Inductronic D-C Amplifier

Stable amplifier provides high degree of resolution even at fractional loads. Reaches steady full scale deflection in a fraction of a second. Interchangeable plug-in range standards for either microamperes or millivolts.



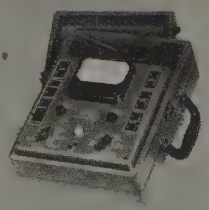
Industrial Circuit Tester—Model 785

A multi-range, multi-purpose, ultra-sensitive analyzer, for laboratory and industrial checking of electrical and electronic circuits. Has 28 practical scale ranges; measures d-c and a-c voltage, d-c and a-c current, and resistance. Accessories available to extend ranges. Compact and portable; furnished in either oak or steel case.



Model 686
Electronic Tube Analyzer

Tests tubes under exact operating potentials. Accurately determines true mutual conductance of all tubes, in accordance with manufacturers' rated operating conditions, or under special operating conditions.



High Frequency Electronic Analyzer
Model 769

A three-in-one instrument providing a self-contained Volt-Ohm-Milliammeter, a high impedance electronic D-C Volt-Ohmmeter, and a probe type Vacuum Tube Voltmeter for use to 300 megacycles. Exceptionally stable and accurate. Has specially designed extremely small RF and D-C probes.

(*Continued from page 58A*)

wet process porcelain insulators has been announced by Victor Insulators, Inc. This booklet illustrates and describes the various steps in the production of wet process porcelain from receipt of raw materials to final testing and shipment of finished insulators. The booklet may be obtained without charge by writing Victor Insulators, Inc., Victor, N. Y.

Antennas and Accessories Catalogue. A 76-page book exclusively cataloguing radio and television antenna systems, antennas, and accessories is available free of charge from United Catalog Publishers. This "Handi-Guide" contains data for all types of antenna equipment with detailed specifications, illustrations, descriptions, and prices. Free copies of the Antenna "Handi-Guide" may be obtained by writing United Catalog Publishers, 110 Lafayette Street, New York 13, N. Y.

Transmission Systems for Automatic Process Control. A new catalogue now ready for distribution describes completely the pneumatic, magnetic, electric, electronic, and electronic-follower transmission systems for use in measurement and control of flow, pressure, liquid level, viscosity, and specific gravity. The illustrated catalogue contains performance characteristics and schematic diagrams of the various systems. Copies of Catalogue *T-50* may be obtained free of charge by writing Fischer and Porter Company, 7250 Jacksonville Road, Hatboro, Pa.

Control Centers. A new 31-page application booklet on control centers is available from the Westinghouse Electric Corporation. Stressing the case for centralizing all controls of an entire system in one group of enclosures, this booklet discusses the characteristics of control centers that make for flexibility of application, ease of servicing, and safety of operating personnel. Three types of control centers are described, and the various electrical components that make up typical units are illustrated and defined. A 3-step building-block system of planning control centers is given, along with check charts to aid the selection of the right control center arrangement. Reference tables for proper selection of starter size are provided. For a copy of this booklet, *B-5621*, write Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa.

Test Methods. Eighty different methods for testing, inspecting, and analyzing some 90 different types of products are listed in a new folder being distributed by American Standards Testing Bureau, Inc., 44 Trinity Place, New York, N. Y. Prepared to show industry and business the scope of service available to them for the quality control of many products, several methods are touched on briefly, such as nondestructive testing; testing for performance; corrosion resistance; protective coatings; chemical analysis; development of specifications; product certification; and the seal of approval.

HIGHLIGHTS.....

President's Address. Under the title, "AIEE Progress," Mr. Quarles' Winter General Meeting address discusses some matters of current interest to members of the Institute (*pages 189–91*).

AIEE Meetings. The recent Winter General Meeting in New York City set an all-time record for attendance and the size of its technical program. Some of the highlights of the meeting are reported (*pages 257–63*). Another recent meeting was the third Conference on High-Frequency Measurements in Washington, D. C., of which the AIEE was a joint sponsor (*pages 267–8*). Coming meetings include the jointly sponsored American Power Conference (*pages 266–7*), the North Eastern District Meeting in Boston (*page 269*), the Southern District Meeting in Louisville (*page 268*), and the Summer Meeting in Atlantic City (*page 269*).

Education and Public Policy. In his keynote speech at the Winter Meeting general session, New York University's Chancellor H. T. Heald considers the future of American education, one of the nation's greatest resources, and its relationship to the national policies which we adopt (*pages 196–9*).

Growth of the Engineer. If the engineer is to accept his share of the responsibility for the social implications arising out of his technical achievements, then it is essential that his growth as an individual keep pace with the times—both professionally and as a social being (*pages 191–5*).

Edison Medalist for 1952. The annual Edison Medal, highest AIEE award, was presented this year to Vladimir K. Zworykin for his contributions to electronic research. Full texts of the addresses by J. F. Calvert, who spoke on the history of the medal, E. W. Engstrom, who outlined the Medalist's career, and Dr. Zworykin's acceptance, are included in this issue (*pages 207–09*).

Good Industrial Relations. With the development of mass production and big business during the past 3 decades, the question of industrial relations has become a complex problem. This article suggests some "steppingstones" towards good industrial relations that can be built by each of the groups involved: management, the employees, and organized labor (*pages 204–06*).

Television Monitoring of Generating Station Stack Emission. As neither the light intensity of the object being viewed is fixed nor can the background be controlled to provide optimum camera-tube response, this type of industrial television is more difficult than most applications. The 2-year-old installation discussed here employs a special automatic electronic-iris-control unit which adjusts the camera lens to the varying light conditions (*pages 224–7*).

Design Chart for Single-Layer Air-Core Transformers. As tapped single-layer air-core coils have wide applications in the electrical and electronic arts, this chart can facilitate design of these coils without resorting to trial and error (*pages 248–9*).

Civil Defense Communications. They are required to give advance warning of impending attack, and after an attack to dispatch and direct forces who combat fires, rescue trapped people, control traffic, and so forth. These communications must be rapid, reliable, secure, simple to operate, and able to interconnect all points between which communication is necessary (*pages 218–22*).

The Combustion Gas Turbine. Gas turbines have been successful commercially as prime movers for over 3 years. Their history suggests that turbines deserve consideration for numerous applications when economic comparisons are being made. Possible applications are included (*pages 252–6*).

Physiologic and Pathologic Effects of Microwaves. Experiments indicate that microwave treatment, by increasing the temperature of the tissues, apparently causes an increase in blood flow. However, particular caution must be exercised as microwave diathermy also can cause cataracts as well as damage to ischemic tissues, or regions in which there are collections of fluid, marked edema, effusions, bony prominences, or a tendency to hemorrhage (*pages 239–44*).

Nuclear Research Laboratories' Power Supply. The requirements are presented in terms of utility and research power. Emphasis is placed on flexibility and safety (*pages 212–18*).

The S. S. United States. Constructed basically as a naval auxiliary, safety, high speed, long range of operation, and rapid conversion from a commercial vessel to troop transport were required. Here the electric installation, more modern and complex than that of any other passenger vessel, receives particular attention (*pages 230–5*).

Air Polution Prevention. Electric generating stations have had millions of dollars spent on their equipment to remove a large percentage of the dust carried by the flue gases. Although electrostatic precipitators are stressed, mechanical collectors are also discussed as well as the advantages of combining them in series to obtain as much as 99-per-cent efficiency (*pages 200–04*).

News Index

Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers (exclusive of ACO's) presented at General and District Meetings. The publications are on an annual subscription basis. In consideration of payment of dues, members may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office 20th & Northampton Streets, Easton, Pa. Editorial and advertising offices 500 Fifth Avenue, New York 36, N. Y. Subscription $12 per year plus extra postage charge to all countries to which the second-class postage rate does not apply; single copy $1.50. Entered as second-class matter at the Post Office, Easton, Pa., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925.

March 1953, Vol. 72, No. 3. Number of copies of this issue 55,500

Field tests with 380 kV ortojector breaker

Tests

November 10th, 1952, 24 hours after its installation in Harspränget, Sweden, 25 n
north of the arctic circle, the **first 380 kV oil circuit breaker** ever in se
was extensively tested.
While in earlier field tests on a single break the short circuit rating had been
monstrated, in the present tests the **line and reactance interrupting perform**
was thoroughly investigated by switching the 300 miles of line, the 345 MVA tr
formers and up to 180 MVA reactors in all combinations.

Interrupted load	Voltages before tests	Overvoltage factors r ted to phase voltag
Line 300 miles	300 – **538 kV**	1,4 – 2,4
Line 300 miles + 330 MVA transformer (at the other end of the line)	302 – 410 kV	1,1 – 2,2
Line 300 miles + transformer + reactor 60-180 MVA (at the other end of the line)	410 kV	1,0 – 1,8
345 MVA transformer at no load	436 kV	1,0 – 1,5
345 MVA transformer + reactor 40 - 80 MVA	390 – 412 kV	1,2 – 2,4

All operations were performed to **complete satisfaction**, mechanically and el
cally. The overvoltages recorded during tests remained below 2,5 times phase
tage that is below 1,44 times line voltage even with voltages before test of 5
RMS. The ortojector breaker passed these most difficult tests under the hi
voltages successfully **without resistors.**

Features 8600 MVA symmetrical interrupting rating / 1000 A rated curr
380 kV rated voltage / 1775 kV impulse withstand level.
The 380 kV ortojector breaker is a **low oil content breaker** with two oil
interrupting chambers supported by solid insulating bases. Only two breaks per p
operated by a mechanical mechanism assure complete reliability in operatio
simplicity in maintenance.
The **vertical disposition of the insulation** gives full protection against rain
and condensation.

SPRECHER S&S &SCHUH

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ATELIERS DE CONSTRU
ELECTRIQUES DE DELL
VILLEURBANNE FRANC

AMERICAN LAVA CORPORATION... SPOTLIGHTS ALSIMAG® METAL-CERAMIC COMBINATIONS

Lead-Through Hermetic Terminals

(Designed for soft-soldering)

Superior ceramic terminals for hermetic seals are now available in an AlSiMag Alumina Body which meets L5A Requirements of JAN-I-10 specifications.

Some sizes and styles are carried in stock . . . or they can be custom made for your specific requirements. *STOCK ITEMS ARE SHOWN IN BULLETIN NO. 524, SENT ON REQUEST.*

Our broad experience in metal-ceramic combinations is available to you on your request.

51ST YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

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NEW ENGLAND: 1374 Mass. Ave., Cambridge, Mass., Kirkland 7-4498 • PHILADELPHIA: 1649 N. Broad St., Stevenson 4-2823 • ST. LOUIS: 1123 Washington Ave., Garfield 4959
CHICAGO: 228 N. LaSalle St., Central 6-1721 • SOUTHWEST: John A. Green Co., 6815 Oriole Dr., Dallas 9, Dixon 9918 • LOS ANGELES: 5603 N. Huntington Dr., Capital 1-9114

INDUSTRIAL NOTES ....

General Electric Notes. Warde B. Stringham, of Washington, D. C., has been elected a commercial vice-president of the General Electric Company by the Board of Directors. He will succeed Edwin E. Potter who is retiring after 43 years of service.

The General Electric Supply Company will establish new district offices at Grand Rapids, Mich., Sacramento, Calif., and San Antonio, Tex. Wilfred J. Richter will be district manager at Grand Rapids; Edwin M. Ames, district manager at Sacramento; and Berl M. Raborn, district manager at San Antonio. They now will have 45 district offices.

Roger F. Long of Chicago, Ill., has been appointed sales manager for equipment tube sales in the central region, with headquarters in Chicago. He has been a sales representative for G-E equipment tube sales since 1948.

Establishment of 26 district offices of the Major Appliance Division in the reorganization of the division's field forces, was announced by Herbert A. Warren, manager of distribution. The new districts and managers for the Eastern region with headquarters at New York City are: New York (manager to be announced); Boston, Mass., A. E. Andres; Hartford, Conn., J. E. Stormont; Buffalo, N. Y., Lee D. Nutter; Philadelphia, Pa., J. F. Pieper; Allentown, Pa., T. R. MacDougall; Pittsburgh, Pa., R. A. Sweeney. The Southeastern region will have its headquarters at Atlanta, Ga., with the following districts and managers: Atlanta, W. R. Hull; Washington, D. C., Ralph J. Mowry; Raleigh, N. C., J. Murray Walker; Nashville, Tenn., C. E. Mighell; Memphis, Tenn. (to be announced). The Central region with headquarters at Chicago, Ill., will have the following districts and managers: Chicago, (to be announced); St. Paul, Minn., J. T. Davis; Omaha, Nebr. (to be announced); Detroit, Mich., Edward L. Stehle; Indianapolis, Ind., Dorian B. Hull; Cleveland, Ohio, Robert B. Beale, Jr. The Southwestern region will have its headquarters at Dallas, Tex.: Dallas, R. V. MacDonald; Kansas City, Mo., (manager to be announced); Houston, Tex., (to be announced); Denver, Colo., L. B. Bundy. The Western region with headquarters at San Francisco, Calif.: San Francisco, Calif., H. Gordon Smith; Seattle, Wash., Robert T. Skeer; Los Angeles, Calif., Charles M. Rowland; Salt Lake City, Utah, Fred K. Hagar.

T. J. Marshall and K. W. Macdonald have been appointed Construction Materials district representatives. Mr. Marshall has been assigned to handle Accessory Equipment products in the North Central district. His office will be at 5726 West 51st Street, Chicago, Ill. Mr. Macdonald, will represent the Columbus trading area of the division's Great Lakes district. His office will temporarily be at 925 Euclid Avenue, Cleveland, Ohio.

RCA News. Emanuel Sacks has been named Vice-President and General Manager of the RCA Victor Record Department. In addition to his new responsibilities, Mr. Sacks will continue to function as Staff Vice-President of RCA. As head of the Record Department, he succeeds Paul A. Barkmeier, who has been named Vice-President and Director of Regional Offices of the RCA Victor Division.

Election of Lewis L. Strauss as a Director of the Radio Corporation of America and of the National Broadcasting Company was announced.

Servel News. Paul R. Kennedy has been appointed southern manager for the public utility division of Servel, Inc., with headquarters in Atlanta, Ga. He will be in charge of the company's relations with utility companies throughout the South.

W. E. Baker, vice-president and assistant to the president of Servel, Inc., has retired. He came to Servel in 1934 as vice-president in charge of manufacturing continuing as the company's production chief until 1951, when he was appointed vice-president and assistant to the president. Before joining Servel, Mr. Baker spent over 20 years in various executive positions with Westinghouse and General Motors.

Sprague Electric Announcement. Gilbert B. Devey has been appointed to the Application Engineering staff of the Sprague Electric Company, North Adams, Mass., it has been announced. Mr. Devey will co-ordinate Sprague's application engineering efforts on printed circuits and ceramics.

IRC Opens Chicago Sales Office. The International Resistance Company, Philadelphia, Pa., announces the opening of a Chicago Sales Office, located at 4013 North Milwaukee Avenue, Chicago 41, Ill. Frank R. McMillan, formerly Assistant Sales Manager of IRC's Radio Division, has been appointed District Manager, and Robert M. Butler, previously Assistant Sales Manager—Merchandise Division, has been named Assistant Mana

Armour Research Foundation Announces Appointment. John P. Skinner, assistant manager for program development at Armour Research Foundation of Illinois Institute of Technology, has been named manager of the Foundation's Magnetic Recording division. Mr. Skinner's office serves some 50 domestic and foreign companies licensed to manufacture magnetic recording equipment under Foundation patents. This involves furnishing requested information to licensees, informing them of new developments, and developing marketable applications of magnetic recording.

Ford Instrument Company Names Safety Director. Gilbert F. Tyler has been appointed Safety Director of the Ford

(*Continued on page 22A*)

KLIXON

C6360

MOTOR STARTING RELAY LEADS

Since these KLIXON starting relays are used as standard equipment by a great many leading manufacturers of refrigerating units, insulation must be able to withstand both high and low ambient temperatures. Natvar 400 tubing has excellent flexibility and resistance to oil and moisture over a very wide temperature range.

ARE INSULATED AND PROTECTED *with*

NATVAR 400

EXTRUDED PLASTIC TUBING

The KLIXON C6360 is a current type relay which means that the entire motor current flows through it. Therefore the wire in the coil winding is heavy enough to be used for leads, eliminating screw terminals. And since sleeves of Natvar 400 are reasonably low in cost, and are easily slid over the leads, assembly is quicker and less expensive. Also, leads can be color coded, because Natvar 400 is furnished in bright, distinctive colors.

KLIXON Protective devices and controls, manufactured by Spencer Thermostat Division of Metals & Controls Corporation, are used by foremost makers of refrigerating and other electrical equipment to assure safe, continuous operation under all service conditions.

Since reliability of KLIXON devices is essential, only the best materials are used. Natvar 400 extruded plastic tubing has been selected as the most suitable lead insulation for the starting relay shown above because of its excellent physical and electrical properties and its dependable uniformity.

Natvar 400 and other Natvar flexible insulating materials are available either from your wholesalers stock or direct from our own.

Natvar

Natvar Products

- Varnished cambric—straight cut and bias
- Varnished cable tape
- Varnished canvas
- Varnished duck
- Varnished silk
- Varnished special rayon
- Varnished Fiberglas cloth
- Silicone coated Fiberglas
- Varnished papers
- Slot insulation
- Varnished tubing and sleeving
- Varnished identification markers
- Lacquered tubing and sleeving
- Extruded plastic tubing and tape
- Extruded plastic identification markers

Ask for Catalog No. 22

NATVAR CORPORATION

FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION

TELEPHONE RAHWAY 7-8800

CABLE ADDRESS NATVAR: RAHWAY, N. J.

203 RANDOLPH AVENUE • WOODBRIDGE, NEW JERSEY

(*Continued from page 18A*)

Instrument Company. Mr. Tyler was formerly superintendent of the safety engineering division of the National Surety Corporation, and before that worked in the same capacity for the Atlantic division of Pan American World Airways.

Simplex Wire to Build New Plant. The Simplex Wire and Cable Company of Cambridge, Mass., has announced plans to establish a branch factory at Newington, near Portsmouth, N. H., for the manufacture of submarine cable. Present plans call for the employment of 200 persons. Operations will be carried on by the Submarine Cable Division of the company.

NEW PRODUCTS • •

High-Voltage Selenium Rectifiers. Two high-voltage selenium rectifiers, type *V75HF* and type *V100HF*, have been developed by International Rectifier Corporation, El Segundo, Calif., for use in television equipment in which long life and reliability are of prime importance. The units are designed with ferrule terminals for insertion into standard 30-ampere fuse clips. The diameter of the units is 9/16 inch. The type *V75HF* is $3^1/_4$ inches long and the type *V100HF* is $4^5/_{32}$ inches long. Both units are designed to deliver 5 milliamperes into a capacitive load at a d-c output voltage of 1,500 and 2,000 volts respectively. These cartridge rectifiers are designed to meet joint Army-Navy humidity, altitude, vibration, and shock specifications.

Static Detector. An improved static detector has been announced by Keithley Instruments. The model *2005* static detector clips onto a Keithley vacuum tube electrometer, providing a convenient and highly sensitive combination for detecting and locating static charges. The electrometer accessory consists primarily of two concentric, telescoping tubes and a center aluminum rod. When clipped over the HI terminal of the electrometer, the tubes act as a shield for the rod, limiting sensitivity to a narrow cone along their axis. Qualitative results are obtained by noting the deflection of the meter pointer. Sensitivity can be varied by extending or lowering the inner tube. With the tube lowered to maximum sensitivity, a charged pocket comb throws the pointer off scale from a distance of 10 feet. Full details are available on request to Keithley Instruments, 3868 Carnegie Avenue, Cleveland 15, Ohio.

Carrier Telegraph System. Either physical or carrier derived voice circuits can be divided into a number of telegraph channels with the Lenkurt type *24C* amplitude-modulated carrier-telegraph equipment. Up to 18 duplex telegraph

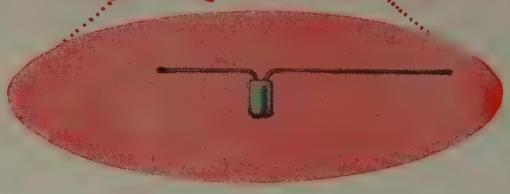
(*Continued on page 32A*)

INTERNATIONAL RECTIFIER CORPORATION

EL SEGUNDO CALIFORNIA

Selenium Rectifiers

SMALLEST



SELENIUM DIODES

DIAMETER: From 1/8" to 13/32"
LENGTH: From 1/4" to 1/2"
RMS applied voltage:
From 26 volts to 104 volts
RMS input current:
max. 500 microamperes
DC output voltage:
From 20 volts to 80 volts
DC output current: avg. from 200 microamperes to 5 milliamperes
Reverse Leakage at 10 volts RMS:
0.6 microamperes to 2.4 microamperes
Potted in thermosetting compound
Temperature Range:
From -60° C to 100° C
Available in 1, 2, 3 and 4 cell Diodes

Send for Bulletin SD-1

TO

LARGEST

POWER RECTIFIERS

CELL SIZES: From 1"x 1" to 6¼"x 7¼"
CURRENT RATINGS, per cell:
0.125 amperes to 7 amperes
VOLTAGE RATINGS, inverse per cell:
22 volts rms to 40 volts rms
Efficiency to 87%. Power factor 95%
Suitable for oil immersion.
Ratings to 250 KW. *Send for Bulletin C-349*

INTERNATIONAL RECTIFIER

CORPORATION

General Offices: 1521 E. Grand Ave., El Segundo, Calif. • Phone: El Segundo 1890
Chicago Branch Office: 205 West Wacker Drive • Phone: Franklin 2-3889
New York Branch Office: 12 West 32nd Street, N. Y. 1 • Phone: Chickering 4-0017

(*Continued from page 22A*)

channels can be derived from a single 4-wire circuit or up to 9 duplex telegraph channels from a single 2-wire circuit with this equipment. The derived channels can be used for teleprinter service, remote control, and other telegraphic indication. Frequency allocations and levels are compatible with other widely used carrier-telegraph systems. A type *24C* telegraph system consists of a number of channel terminal panels and common equipment as required. The transmitter, receiver, and relays for each channel are included on the basic channel terminal panel which occupies $3^{3}/_{4}$ inches of vertical mounting space on one side of a standard 19-inch equipment rack. All channel terminal panels are identical with the exception of the sending and receiving filters and the carrier frequency oscillators. Convenient access is provided for all controls and terminations to simplify installation, adjustment, and maintenance, and a selector switch on the panel provides four loop options. Complete information about the *24C* carrier telegraph system can be obtained from the Lenkurt Electric Company, 1105 County Road, San Carlos, Calif.

Plastic Pole and Bracket Cable. A plastic-insulated pole-and-bracket cable manufactured by Anaconda Wire and Cable Company, New York, N. Y., is now available in addition to the conventional rubber-insulated construction for street lighting service. Voltage rating of the new cable is 600 volts between conductors; 6,000 volts from conductor to ground. It is constructed of two flexible stranded conductors, each insulated with Densheath polyvinyl chloride; one black and one white, laid parallel; black polyethylene jacket; finished cable is oval-shaped.

Rheostat Tandem Coupling Kits. Two rheostat tandem coupling kits, which enable purchasers to mount certain standard Ohmite rheostats in tandem, are being offered by the Ohmite Manufacturing Company, Chicago, Ill. Each kit consists of a steel "U" frame, mica washer, coupling, Allen wrench, and assembly instructions. The large frame is designed for use with Ohmite model *G*, *K*, or *L* rheostats. The small frame is designed for use with Ohmite model *H* or *J* rheostats.

Magnetic Starters, Contactors, and Relays. Announcement has been made by Cutler-Hammer, Inc., 312 North 12th Street, Milwaukee 1, Wis., of a new line of magnetic starters, contactors, and relays. This new line incorporates a simple 5-unit construction designed to install easier, work better, and last longer. A wrap-around cover pulls off, fully exposing the front and both sides of the unit for 180-degree accessibility. The five independent parts consist of two contact blocks, a magnet coil, an armature,

(*Continued on page 34A*)

Transmission Towers by AMERICAN BRIDGE handle nation's first 330,000-volt line

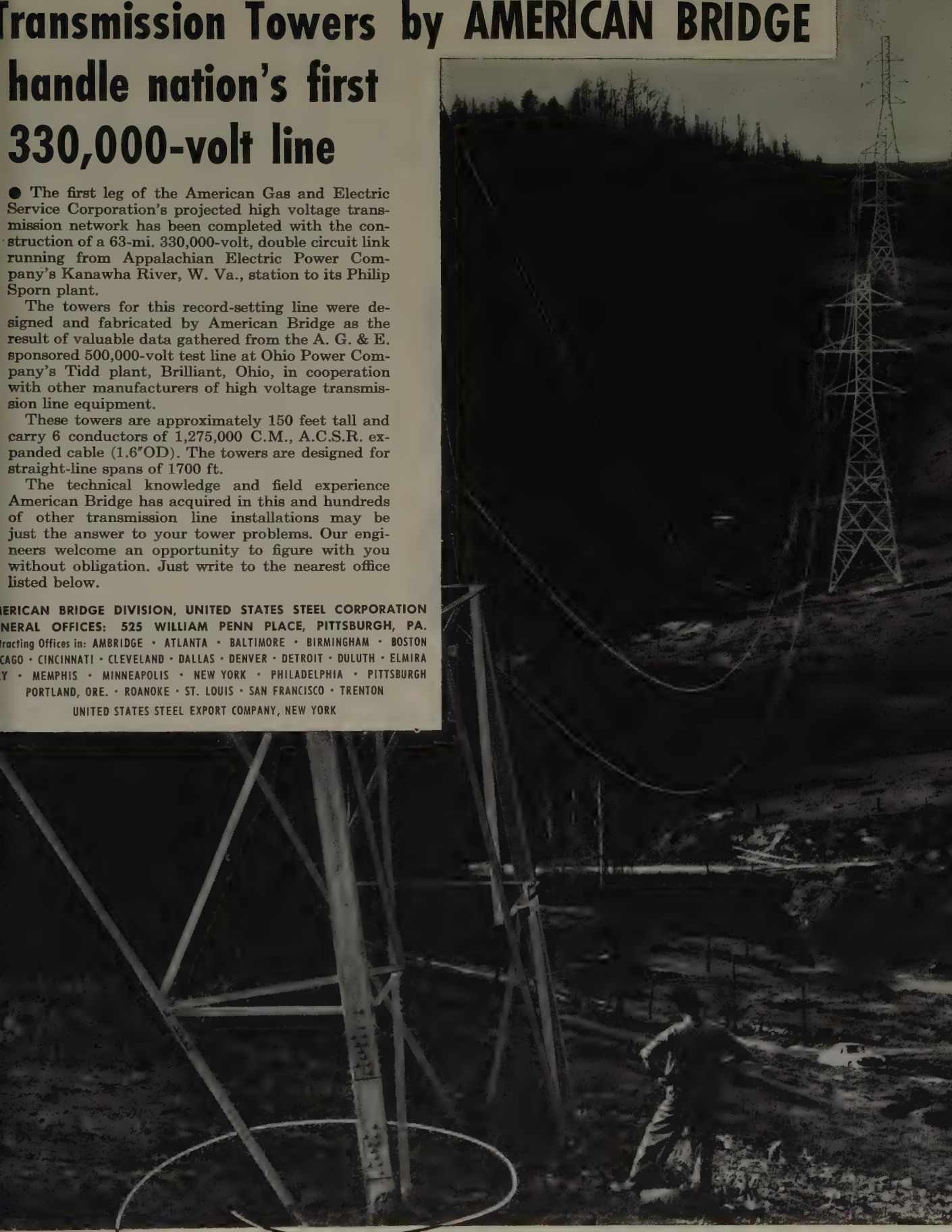
● The first leg of the American Gas and Electric Service Corporation's projected high voltage transmission network has been completed with the construction of a 63-mi. 330,000-volt, double circuit link running from Appalachian Electric Power Company's Kanawha River, W. Va., station to its Philip Sporn plant.

The towers for this record-setting line were designed and fabricated by American Bridge as the result of valuable data gathered from the A. G. & E. sponsored 500,000-volt test line at Ohio Power Company's Tidd plant, Brilliant, Ohio, in cooperation with other manufacturers of high voltage transmission line equipment.

These towers are approximately 150 feet tall and carry 6 conductors of 1,275,000 C.M., A.C.S.R. expanded cable (1.6″OD). The towers are designed for straight-line spans of 1700 ft.

The technical knowledge and field experience American Bridge has acquired in this and hundreds of other transmission line installations may be just the answer to your tower problems. Our engineers welcome an opportunity to figure with you without obligation. Just write to the nearest office listed below.

ERICAN BRIDGE DIVISION, UNITED STATES STEEL CORPORATION
NERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.
Iracting Offices in: AMBRIDGE • ATLANTA • BALTIMORE • BIRMINGHAM • BOSTON
CAGO • CINCINNATI • CLEVELAND • DALLAS • DENVER • DETROIT • DULUTH • ELMIRA
Y • MEMPHIS • MINNEAPOLIS • NEW YORK • PHILADELPHIA • PITTSBURGH
PORTLAND, ORE. • ROANOKE • ST. LOUIS • SAN FRANCISCO • TRENTON
UNITED STATES STEEL EXPORT COMPANY, NEW YORK



DESIGN REDUCES FOUNDATION INSTALLATION COSTS. Important savings in time, labor, and materials were made possible through use of steel grillage earth anchors and variable leg extensions as shown above. Many other simplified installation and frill-free construction features are obtained through American Bridge designs.

AMERICAN BRIDGE

USS TRADE MARK

UNITED STATES STEEL

(*Continued from page 32A*)

and a 3-coil or 2-coil overload relay mounted on a steel panel. Each part can be removed from the front without disturbing another part. The line features a 3-coil adjustable overload relay permitting four ratings from each heater coil by changing its position. This adjustability provides protection within 3 per cent of full-load motor rating. The 3-coil overload offers better protection against single phasing where unbalanced or unstable line conditions may occur. The double-break contacts, made of a special silver alloy, can be inspected by pulling off a snap-on cover; the contacts can be removed without tools. The complete contact block can be removed by loosening two screws; the overload relay by turning out two screws. The armature, which pivots on rolling bearings, and the magnet coil may be replaced easily without tools. All terminals are angled to face front, and are equipped with solderless connectors that take a vice-grip on solid or stranded wire, or both, or wire of different sizes.

Standard Inductors. The type *1482* Standard Inductors with several improved characteristics have been announced as replacements for the long-used type *106* inductors by General Radio Company, 275 Massachusetts Avenue, Cambridge, Mass. The new inductors are offered in 1–2–5 unit values. The methods used in constructing and mounting the new inductance standards make them very stable over long periods of time. A uniform progressive banked winding is applied around a low thermal expansion ceramic core having an elliptical cross section to avoid sharp bends in the winding. Adjustment is made to a nominal accuracy of ±0.1 per cent of absolute inductance except on the two smallest units. After adjustment they are packed in granulated cork into a cylindrical carton together with some silica gel to insure dehydration. The carton, supported on dowels, is cast with a potting compound in the aluminum cabinet, thus hermetically sealing the inductor. The actual inductance of each unit is measured and entered on the calibration certificate together with d-c resistance, temperature coefficient, and so forth. Complete data may be obtained from the manufacturer.

Circuitron. The Circuitron is a new type of printed circuit using a radically different method of bonding the pattern to the insulating base. The conductive pattern can be run from one side of the base material to the other by plating through holes, maintaining circuit continuity without the need for eyelets or other hardware. This permits crossovers, greater design flexibility, and easy adaptation to single-dip soldering. Copper, silver, and other metals, in any specified thickness, can be used for the conductive circuit. The pattern can be overplated with nickel, silver, rhodium, or gold. Circuitrons also can be supplied with a solder or tin coating

(*Continued on page 52A*)

durable, less bulky, insulated wire. our machines."

grinding machines and abrasives

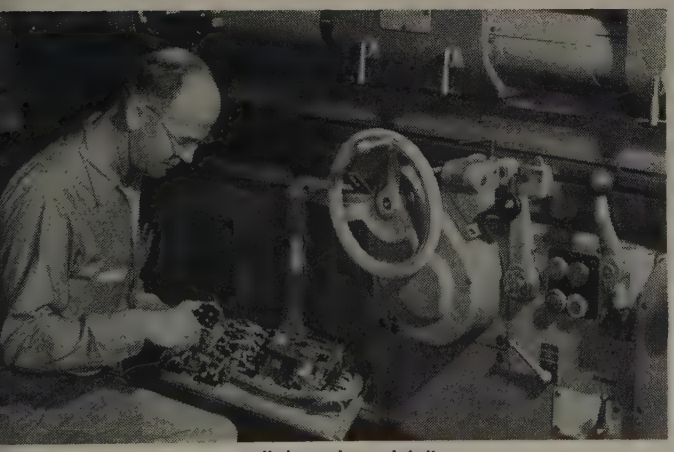
to oil, as well as water conditions. It does not leave a surface smudge and is very clean to work with.

"It is easy to pull through conduit because it's so thin, and it has allowed the design of more compact electrical control panels because it doesn't take up so much room. The jacket is so tough that cable lacing doesn't bite into it like it does with rubber insulation."

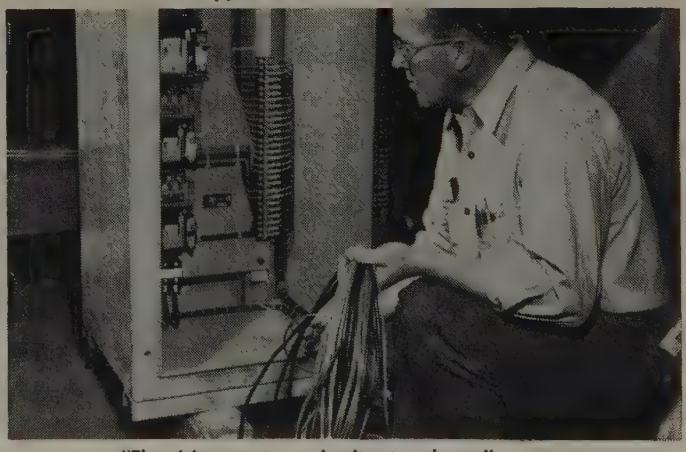
You may be able to replace *several* types of wire with U·S·S Ampyrol. The clean, easy-to-strip jacket is practically impervious to oil, grease, salt spray, industrial fumes, ozone and ultra-violet rays. Send the coupon and get the complete story on this all-purpose insulation.

AMERICAN STEEL & WIRE DIVISION,
UNITED STATES STEEL CORPORATION
GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

"Ampyrol is far better than rubber."



"Easy to pull through conduit."



"Electrician can trace circuits at a glance."

SPECIAL Job!

- mold cured portable cord
- machine tool & building wire
- special purpose wire & cable

WIRE & CABLE

SEND THE COUPON

American Steel & Wire Division
Room CE-33, Rockefeller Building, Cleveland 13, Ohio

☐ Please give me more information on U·S·S Ampyrol.
☐ Have representative call.

Name .....
Title .....
Company .....
Address .....
City ..... State .....

USS

UNITED STATES STEEL

(*Continued from page 34A*)

to facilitate soldering. The conductive pattern can be applied to such base materials as phenolics, melamines, silicones, polystyrene, polyesters, and teflon. Further details are obtainable from Circuitron, Inc., 400 Ninth Street, Hoboken, N. J.

Automatic Safety Feature for Recorder Servicing. Faster, safer instrument servicing of strip chart Tel-O-Set recorders will be possible by adoption of an automatic motor cutout mercury switch developed by the Industrial Division of Minneapolis-Honeywell Regulator Company, Philadelphia, Pa. Through utilization of the quick-disconnect switch the live power line to the chart motor of the recorder is instantly and automatically de-energized when the chassis is withdrawn beyond the safety catch. There is no danger of accidentally short-circuiting disconnected leads dangling against the instrument case. The Tel-O-Set recorder with the quick-disconnect switch was seen as a practical solution to maintenance problems. It eliminates the need for explosionproof switches; the necessity for shutting down an entire panel, or taping hot wires. The new switch is currently available as special optional equipment. It will be in production as a standard product later in 1953.

D-C Overpotential Testing Equipment. Beta Electric Corporation has announced a new line of d-c overpotential testing equipment. There are standard models for 0 to 30 kv direct current, 0 to 50 kv direct current, and 0 to 120 kv direct current, as well as special models to meet individual requirements. D-c overpotential testing equipment provides the following main advantages. The voltages which are equally searching for defects and physical damage are far less damaging than the equivalent alternating voltages. The slope of the voltage endurance curve is such that the time of voltage application is not nearly so critical with direct current as with alternating current. The problems associated with d-c testing of large equipment are far simpler, as a testing device with limited capacity can be used. Therefore, the d-c tester is a small, relatively portable device which can utilize any convenient power supply. The use of the d-c test voltages required will give assurance that the insulation has passed a voltage test which can be co-ordinated with conventional machine lightning protection. Comprehensive information is available from Beta Electric Corporation, 333 East 103d Street, New York 29, N. Y.

Improved Hand Hydraulic Tool. Three improvements in the AMP Hand Hydraulic Tool, which crimps AMP Heavy Duty Solderless Terminals to stranded or solid wire, have been announced by Aircraft-Marine Products, Inc., Harrisburg, Pa. This self-contained unit has interchangeable die inserts for eight wire sizes from 8 to 4/0. The tool head, in which the

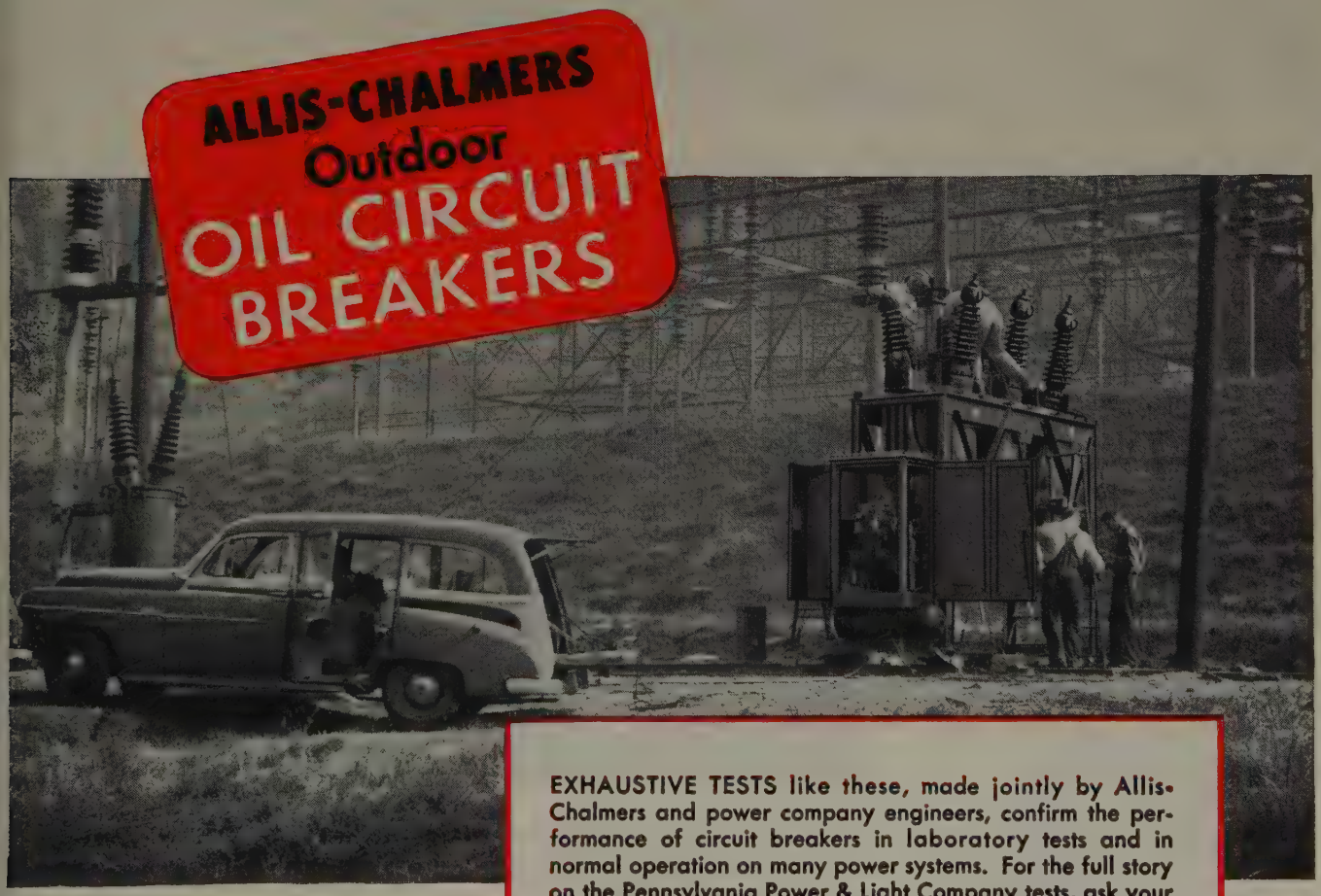
(*Continued on page 56A*)

HOW MUCH Can a Breaker Take?

Here's the Answer Provided by Field Tests on Pennsylvania Power & Light Company System

In a single test series, a standard Allis-Chalmers 69-kv breaker provided Pennsylvania Power & Light Company engineers with positive proof of its ability to:

1. Interrupt a total kva power of approximately *18 times* its interrupting rating — *with no maintenance or adjustment* during the test period.
2. Include, in the total, *eleven* fault interruptions at or above full breaker rating.
3. Pass a group of line-charging and discharging tests *without a restrike.*
4. Show, on inspection after test, that more service could safely be expected.



Standard production-line FZO-151-69F breaker was used for these field tests.

EXHAUSTIVE TESTS like these, made jointly by Allis-Chalmers and power company engineers, confirm the performance of circuit breakers in laboratory tests and in normal operation on many power systems. For the full story on the Pennsylvania Power & Light Company tests, ask your A-C representative for Bulletin 71R7855, or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3791

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

(*Continued from page 52A*)

crimping dies are inserted, has been redesigned and provided with a spring-loaded latch. This provides split-second opening to permit quick removal of the completed terminal, as well as to remove the tool from continuous wire and to change the dies. Complete 360-degree axial rotation of the head has been provided to permit crimping of terminals to cables in cramped or awkward locations. A cradle is now provided as standard equipment with this tool, which permits its convenient use as a bench tool. Off the bench, it protects the tool and facilitates handling. This tool develops 12 tons crimping pressure safely and easily. Its preliminary take-up feature holds the terminal in the dies while the wire is inserted, making 1-man operation quick and efficient. When the crimp is completed, the pressure is released automatically, eliminating guesswork in obtaining uniform termination.

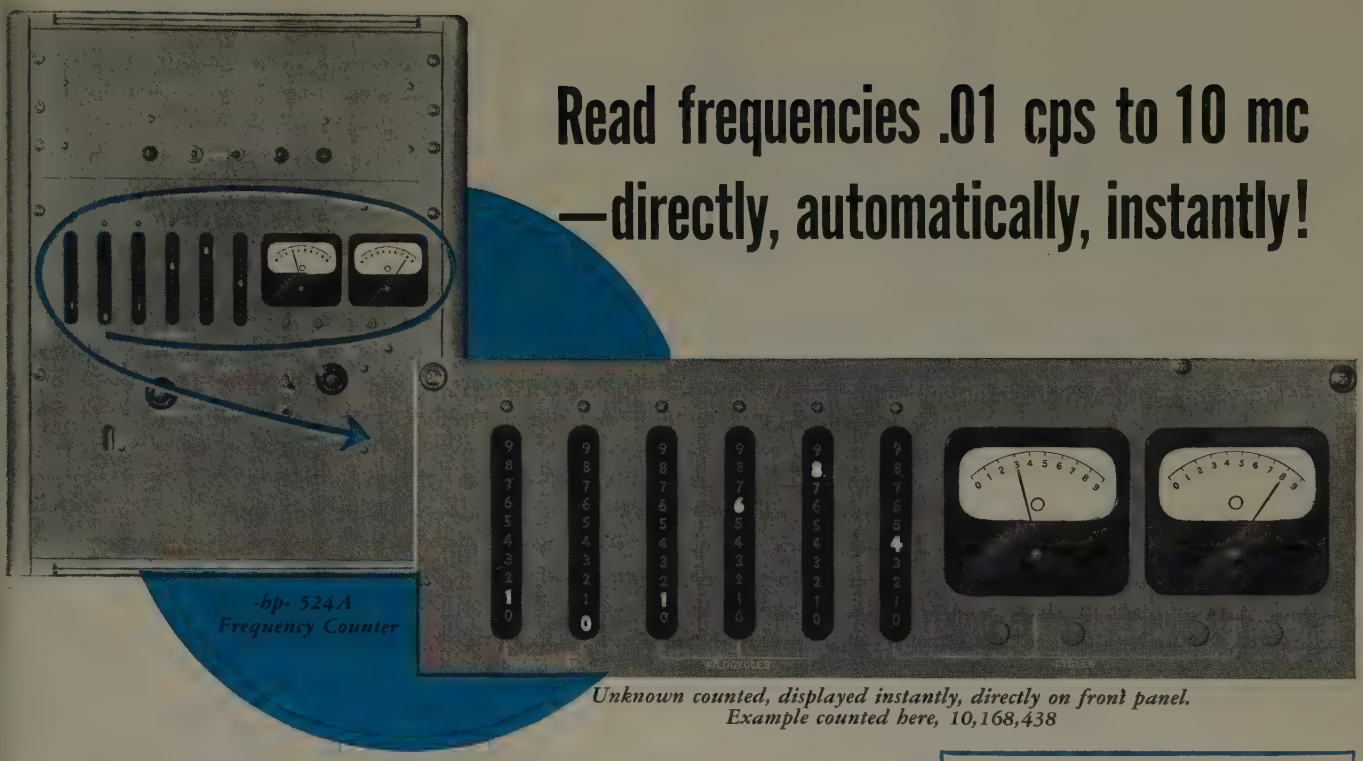
Electric Conduit. Sealtite flexible electric conduit type *UA* is the first of its kind to gain Underwriters' Laboratories approval for use in wet locations. This liquidtight flexible metal conduit is manufactured by The American Brass Company, Waterbury, Conn. The tough, extruded synthetic covering over Sealtite *UA*'s flexible metal core protects wiring against moisture, oil, dirt, chemicals, and corrosive fumes on permanent and temporary installations. The conduit is made of spirally wound, interlocked, zinc-plated steel strip with a copper bonding conductor wound spirally in the space between each convolution on the inside of the conduit. Applications of this moistureproof conduit are suggested to overcome the problems of movement, vibration, and misalignment, both indoors and outdoors.

Air-Cooled Ignitron. National Electronics, Inc., have developed a 56-ampere ignitron which does not require water cooling and is electrically similar to the *5551* size B ignitron tube. Elimination of water cooling is expected to permit use of ignitron tubes where their application has previously not been feasible. This tube, which is designated *NL-1005*, is designed for forced air cooling but may be used at reduced ratings with free ventilation. In the welding control application the *NL-1005* is the approximate equivalent of a 300-ampere magnetic contactor. The tube is capable of controlling maximum rms demand current of 2,400 amperes at 250 volts alternating current or 1,200 amperes at 500 volts alternating current. Maximum average anode current rating is 56 amperes direct current. Complete technical data are available from the manufacturer, National Electronics, Inc., Geneva, Ill.

Intervalometer. The model *N10* Intervalometer is a lightweight, compact instrument for controlling the cycle rate of camera recording devices and other small electrically operated apparatus. Puls

(*Continued on page 64A*)

Read frequencies .01 cps to 10 mc —directly, automatically, instantly!



Unknown counted, displayed instantly, directly on front panel. Example counted here, 10,168,438

- **Measures frequency or period**
- **Direct reading, no calculations**
- **No complex equipment set-up**
- **Easy for non-technical personnel**
- **Accuracy 1/1,000,000 ±1 count**

-hp- 524A FREQUENCY COUNTER is the first commercial equipment to display directly and instantly any unknown frequency from .01 to 10,000,000 cps. It performs all functions of a frequency standard, interpolating system and detector; in frequency determination work, it eliminates need for amplifiers, oscillators, multivibrators and oscilloscopes. The instrument has a wide variety of uses including transmitter and crystal frequency measurement, filter characteristic determination, oscillator calibration, r.p.m. determination (to 600,000,000 r.p.m.) frequency drift, random events per unit time, etc. It also serves as a precision frequency standard.

FREQUENCY, PERIOD READINGS

For high frequencies, *-hp-* 524A counts and displays unknown frequencies over time intervals of 10, 1, 0.1, 0.01, and 0.001 seconds. Counting and display periods are equal and automatically cycled. Count is displayed repetitively, or "held" by pressing "manual" button.

For low frequencies, the instrument measures period or duration of one low-frequency cycle in microseconds. A 10 cps sample is taken to establish this period. As in frequency counting, periods may be displayed repetitively or "held".

CIRCUIT

-hp- 524A operates on pulse counting techniques. Unknowns are applied through a wide-band squaring amplifier to a fast gate controlled by a time base generator. When the gate is open, unknown is applied to counting circuits. When gate is closed, circuits remember and display frequency in cps or period in microseconds. Time base circuits are controlled by a high-stability crystal oscillator.

See your -hp- field engineer or write direct for details.

BRIEF SPECIFICATIONS

COUNTING RATE: 10 mc maximum.
PRESENTATION: 8 places, direct reading.
COUNT PERIOD: 0.001, 0.01, 0.1, 1, 10 sec.
LOW FREQUENCIES: Permits low frequencies to operate as time base. Duration of one cycle is displayed in microseconds.
ACCURACY: ± 1 count ± 2/1,000,000 per week. (Higher accuracy external standard may be employed.)
PERIOD MEASUREMENT: Within 0.3% up to 300 cps: within 1 μsec between 300 cps and 10 kc.
EXTERNAL 100 KC TIMING CIRCUIT: For higher accuracy. Requires 1 v across 50,000 ohms shunted by 30 μμfd.
INPUT VOLTAGE: 1 v peak minimum.
INPUT IMPEDANCE: Approx. 100,000 ohms, 30 μμfd shunt.
CONNECTORS: Standard BNC type.
POWER SOURCE: 115 v, 50/60 cps, 400 watts.
SIZE: Approx. 28" high, 21¾" wide, 14" deep. Weight 115 lbs. Shipping weight 175 lbs.
PRICE: $2,000.00 f.o.b. factory.
Data Subject to Change Without Notice

hp
ELECTRONIC
MEASURING INSTRUMENTS

HEWLETT-PACKARD COMPANY 2456-A PAGE MILL ROAD · PALO ALTO, CALIFORNIA, U.S.A.

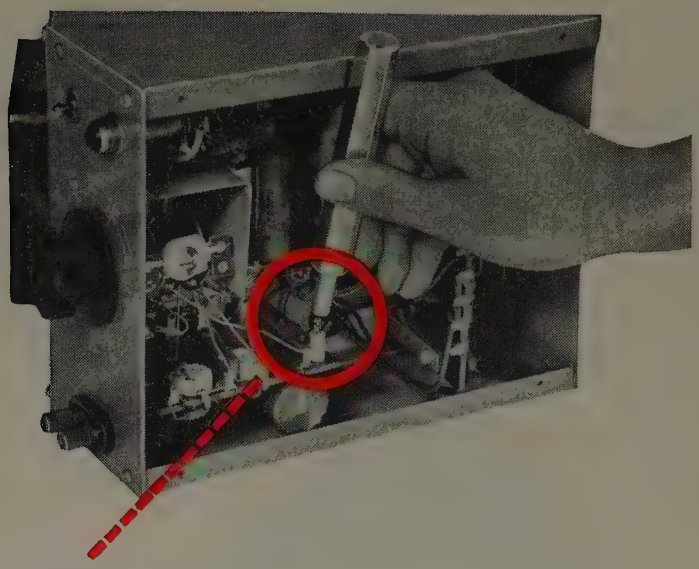
(*Continued from page 56A*)

rates per second are 1, 2, 4, 5, 8, and 10 and the pulse length is variable from 2 to 70 milliseconds. The controlling motor is a chronometrically governed instrument which has an accurate speed regulation. The motor speed regulation is on the order of ±0.5 per cent. The motor itself is completely shielded and is filtered to eliminate radio interference. The Intervalometer is insensitive to operating position and the application of 15-gram loads in any direction will not adversely affect its operation. Satisfactory operation over the present-day requirements of aircraft has been incorporated in the design of the unit. It may be used within a temperature range of −50 to 150 degrees Fahrenheit. For more information concerning the Intervalometer, model *N10*, as well as for special applications, write to Photographic Products Inc., 6916 Romaine Street, Hollywood 38, Calif.

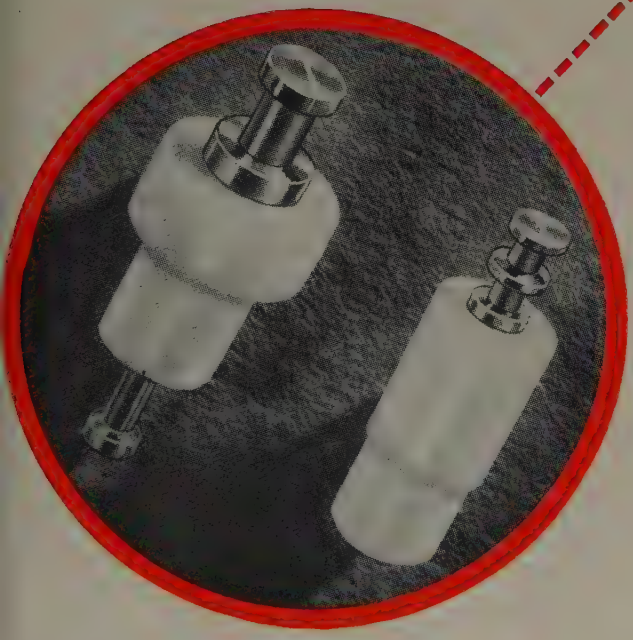
Panel Mounting Precision Potentiometers. A series of panel mounting precision potentiometers, Dekapot model *DP-211*, have been introduced by Brown Electro-Measurement Corporation. These instruments achieve a new order of accuracy in potentiometers with linearity to better than ±0.01 per cent and total resistance to better than ±0.05 per cent. Rather than the single resistance element used in conventional potentiometers, the Dekapot has two decades of fixed resistors and an interpolating slidewire to accomplish the voltage division. The dial arrangement gives an effective scale length of 390 inches. This is approximately the equivalent of a 100-turn helical potentiometer. Extreme ease of operation is provided with the Dekadial. The digits of a given setting are read directly in a horizontal line on the flat face of the operating dial. The use of nonreactive precision fixed resistors in the resistance decade provides good frequency response. The resistance wire used has a temperature coefficient of less than ±0.002 per cent per degree centigrade. These units are available in total resistances of 10,000 ohms. Complete specifications are available from the company, 4635 S. E. Hawthorne Boulevard, Portland 15, Oreg.

Vacuum Switch. A vacuum switch that shuts off the power source when liquid supply runs dry has been announced by Jaycon Associates, Minneapolis, Minn. Designed for use with electric motors and gasoline engines, the "Vac-on" switch has many industrial, marine, and manufacturing applications as a circuit breaker or control where the safety of equipment depends on a suction-delivered lubricant, fuel, water, or similar liquid. It also serves as a warning control where operating conditions depend on a vacuum. The switch is mounted on the suction line and is wired into the power supply on electric motors or the spark system on gasoline engines. When suction falls below a predetermined negative pressure, the switch automatically cuts off the motor or gas

(*Continued on page 66A*)



Du Pont "TEFLON" provides high-temperature insulation



Terminals made by
Sealectro Corp.,
New Rochelle, N. Y.

Dielectric properties remain constant over wide temperature range

Standoff and feed-thru insulator terminals often fail in service due to high-temperature breakdown. Cracking frequently occurs during degreasing operations. And breakage may occur during manufacture. Today's equipment and operating conditions require terminals that eliminate these failures and provide improved, lasting performance.

In designing such improved terminals, Sealectro Corporation sought an insulating material that had good dielectric properties, resistance to high operating temperatures and chemical attack, and the toughness and resiliency to eliminate breakage and cracking. And it had to provide for simple, positive installations.

They chose Du Pont "Teflon"* tetrafluoroethylene resin. "Teflon" is an excellent insulator. Its dielectric constant (2.0) and loss factor (0.0005) are unaffected in temperatures from —80°F. to 400°F. Du Pont "Teflon" is inert to all chemicals except molten alkali metals and fluorine. It is tough, durable . . . will not crack or arc. And the one-piece terminals assure simple, tight, lasting installations.

Du Pont "Teflon" serves many uses in electrical equipment—coaxial spacers, insulation for wire, cables and motor windings, and other parts where high temperatures, service, dielectric strength and durability are required. Perhaps it can help you improve or develop a product. For full information, write E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 213T, Du Pont Bldg., Wilmington 98, Delaware.

*REG. U.S. PAT. OFF.

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY
Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS

(*Continued from page 64A*)

engine. Operating on a spring-loaded rubber-diaphragm principle, the vacuum switch utilizes silver contact points for heavy-duty service. The model for motor use will operate on electric motors up to 2 horsepower on alternating current and 1/2 horsepower on direct current. The gas engine model is designed to short-circuit out the spark plug in event of liquid supply failure. For detailed information, write Jaycon Associates, 404 North Washington Avenue, Minneapolis, Minn.

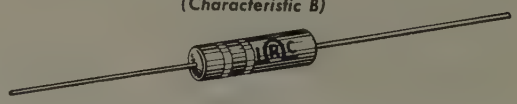
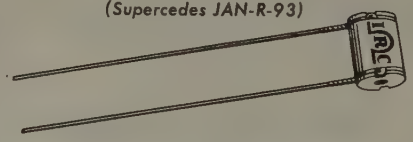
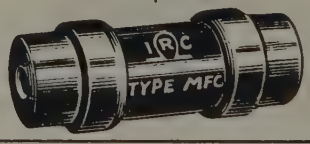
Magnetic Impulse Counter. The Kellogg magnetic impulse counter is an electromagnetic impulse-counting and storing device which may be described as a specialized single-core dual-winding plural-armature relay. Actuated by electric impulses, it performs the counting and marking function of a chain of 10 to 20 relays, or of a 2-magnet 10-point stepping switch, but at a lower cost and with a considerable saving of space while providing excellent operating characteristics and reliability. Ten individual armatures are provided in the counter, each controlling a make set and a break set of contacts. The armatures are operated sequentially in response to impulses of the digit series being recorded. Armatures once actuated are held in position by residual magnetism, requiring no holding current. Release of the armatures is accomplished by energizing a second winding which acts to neutralize the residual magnetism in the mildly hard core. The counting sequence is controlled electromagnetically through an auxiliary restraining pole member for preventing response of any armature after the first until it has been preliminarily advanced, together with a simple armature interlinkage which causes the next succeeding armature to advance preliminarily at the end of the instant operating impulse. For further information and specifications, write Kellogg Switchboard and Supply Company, 79 West Monroe Street, Chicago, Ill., Department MIC-14.

High-Speed Rotary Exhaust Machine. Consolidated Vacuum Corporation has announced the availability of a new high-vacuum high-speed exhaust and sealing machine to meet the growing demands of the electronics industry for higher production rates and greater reliability for miniature and subminiature electron tubes. The machine has a number of outstanding features unique to this type of processing equipment. First, there is no traditional slide valve at the center of the machine through which the tubes are vacuum pumped. Rather, pumping is accomplished by an easily demountable packaged unit consisting of mechanical pump, diffusion pump, valves, and compression port. This unit will produce a pressure of 1 micron or lower at the port in the positions immediately ahead of the tip-off. Second, the machine is not indexing, there are no starting and stopping motions. Once started, the turret turns continuously, and sealing in of envelopes to base, transfer

(*Continued on page 68A*)

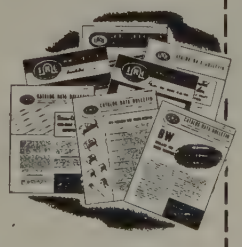
HERE'S YOUR "AT-A-GLANCE" GUIDE to JAN- and MIL-Type Resistors

Want to know which resistors meet what Armed Forces Specifications? Here's the data you need in handy tabular form. All of these resistors are available on short delivery cycle—from the world's largest maker of resistors.

NAME AND DESCRIPTION	SPECIFICATIONS
TYPE BT ADVANCED FIXED COMPOSITION RESISTORS ⅓, ½, 1 and 2 watts. IRC filament-type resistance element. Anchored, non-loosening leads. Extra-Bakelite-sealed against moisture or grounding. Low operating temperature. Excellent power dissipation.	JAN-R-11 Specification *(Type BTS meets rigid G Characteristic)* 
TYPE BW INSULATED WIRE WOUND RESISTORS ½ and 1 watt inexpensive wire wound resistors for low range requirements. Small and completely insulated. Wire resistance element is uniformly and tightly wound on an insulated core.	JAN-R-184 *(Characteristic B)* 
NEW TYPE BOC BORON-CARBON PRECISTOR ½ watt. Latest development in stable film-type resistors. Combines high accuracy and long-time stability. Reduces temperature coefficient of conventional deposited carbon resistors. Replaces high value wire wounds at substantial savings in cost and space. Essential in critical electronic and avionic circuits.	MIL-R-10509A Specification 
TYPE DCC DEPOSITED CARBON PRECISTOR ½, 1 and 2 watts. Latest advance in small-size, high stability resistors. Ultimate in non-wire-wound accuracy. Stable over long periods. Assures low voltage coefficient, low capacitive and inductive reactance in high frequency uses. Efficient and economical in modern electrical and electronic circuits.	MIL-R-10509A Specification *plus latest JAN Specification Proposal* 
TYPE WW PRECISION WIRE WOUND RESISTORS Severe cycling and 100 hour load tests result in almost no resistance change. New winding forms hold more wire for higher resistance. New winding technique eliminates shorted turns. New type insulation withstands humidity. New terminations are rugged, strain-free.	MIL-R-93A Specification *(Supercedes JAN-R-93)* 
TYPE MF SEALED PRECISION VOLTMETER MULTIPLIERS Completely impervious to humidity. Interconnected precision wound coils are encased in glazed ceramic tube—hermetically sealed. Multiple-layer windings insure resistor against breakdown. Compact, rugged, stable, easy to install.	JAN-R-29 Specification 
POWER WIRE WOUND RESISTORS For exacting, heavy-duty applications. Exceptional mechanical strength; withstand severe vibration. Available in two coatings; a variety of ratings, sizes and terminals; fixed and adjustable types; tubular or flat.	 TUBULAR PWW'S —JAN-R-26A *(G and J Characteristics)* FLAT FRW'S—Correspond to JAN-RW Types

SEND FOR FULL TECHNICAL DATA

Complete data on any or all of these IRC resistors are yours for the asking. Use the handy coupon and be sure to ask about IRC's Industrial Service Plan. It enables you to get prompt delivery of experimental or pilot-run quantities—right from the stocks of your local IRC Distributor.



Wherever the Circuit Says ~W~

INTERNATIONAL RESISTANCE COMPANY

Philadelphia 8, Pennsylvania

In Canada: International Resistance Co., Ltd., Toronto, Licensee

INTERNATIONAL RESISTANCE COMPANY

411 North Broad Street, Philadelphia 8, Pa.

Please send me information on the following (checked) IRC resistor types.

Name and address of local IRC Distributor. ( )

*Name*_____

*Title*_____

*Company*_____

*Address*_____ *City*_____ *State*_____

Type BT's ( ) Type BOC's ( ) Type WW's ( )
Type BW's ( ) Type DCC's ( ) Type PWW's ( )
Type MF's ( ) Type FRW's ( )

(*Continued from page 66A*)

to pumping position, and finally tip-off is accomplished smoothly and automatically. Third, only two large electric motors and one small one are involved, thus reducing maintenance. One large motor drives all the mechanical vacuum pumps through planetary gearing and clutch engagement; another motor drives the turret; and a third is used to move the tube stems from the port after tip-off. Detailed information can be obtained by writing Consolidated Vacuum Corporation, Rochester 4, N. Y.

TRADE LITERATURE

Resin for Coatings. The latest technical information on specifications, formulations and uses of Vinylite Resin *VMCH* as a surface coating is presented in Technical Release *12*, a 16-page booklet published by Bakelite Company, a Division of Union Carbide and Carbon Corporation. Addition of plasticizers, stabilizers, and solvents, and their effects on resin *VMCH* are discussed in the pamphlet. Resin *VMCH* is suggested for use as a blending agent to impart improved adhesion characteristics to other vinyl chloride-acetate resins. The booklet outlines proper methods of selecting and using pigments with regard to reactivity, dispersion, and mixing of colorants with the resin. Several applications of Vinylite Resin *VMCH* are also described in Technical Release *12*. Copies of this booklet may be obtained by writing to Don Masson, Bakelite Company, a Division of Union Carbide and Carbon Corporation, 300 Madison Avenue, New York 17, N. Y.

Precision Extrusions. A complete catalogue covering 4,000 standard extruded aluminum shapes, rod, bar, and tubing available without additional die service charge has been released by Precision Extrusions of Bensenville, Ill. The 98-page wire-bound book contains many features to assist designers, architects, engineers, and purchasing men in the selection of the exact extrusion for the particular application. Included in the catalogue are five major divisions with 35 subdivisions covering structural shapes, architectural, furniture mouldings, standard mouldings, and tubing. An 8-page 2-color opening section covers the complete facilities of Precision Extrusions, basic engineering and design data, and purchasing and shipping information. A complete alphabetical index, die-cut tabs for the major divisions, and index listing on each division page make the catalogue extremely easy to use. Isometric drawings accompany the numerical data to aid quick visualization for some of the more intricate shapes catalogued. Requests for copies of the catalogue should be addressed to: Precision Extrusions, Bensenville, Ill.

Hermetic Seals and Assemblies. The Sealtron Company has released a 32-page

(*Continued on page 70A*)

(*Continued from page 68A*)

catalogue-brochure (*S-53*) featuring photographs, diagrams, and data concerning over 1,600 stock seals and special assemblies. It shows the company's line of electronic and electric control systems, test equipment, components, and communication equipment. The catalogue furnishes complete descriptions and specifications of product lines, pertinent facts about company history, engineering and production achievements, and quality control. It is available without charge from The Sealtron Company, 9701 Reading Road, Cincinnati 15, Ohio.

Measurement and Control. Bulletin *15–16* contains technical data on the application of power measurement transducers to process control. Technical application data on all subjects such as salt operation, pulverizing, clay mixing sodium production, and measurement and control of a-c power plus the measurement and control of d-c power are covered technically. Engineering descriptions of applications of thermal converters, solenoid-plunger ammeter, torquemeter, vacuum thermocouple, rectifying current systems, precision shunt, saturable reactor, and magnetic amplifier are covered. Diagrams, tables of characteristics, and mathematical formulas are supplied in this valuable 12-page booklet. This literature is available from the Minneapolis-Honeywell Regulator Company, Brown Instruments Division, Station 64, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Instrument Transformer Guide. The 1953 edition of the G-E Instrument Transformer Buyer's Guide, containing basic, up-to-date information on the complete General Electric line, has been announced as available from the General Electric Company at Schenectady 5, N. Y. The fully illustrated, 102-page publication, *GEA-4626F*, contains ratings, American Standards Association accuracy classifications, and prices of all G-E indoor and outdoor potential and current transformers. Listings of ratio and phase-angle tests, together with tables covering the mechanical and thermal limits of current transformers, are included.

Industrial Lighting. The latest and most elaborate of a series of "See Better—Work Better" bulletins, designed to promote improved lighting in the nation's industrial plants, has been issued by General Electric's Lamp Division. "Bulletin Number *8*," an 8-page illustrated publication in full color, describes what it calls the "revolution in industrial lighting." This revolution, it states, is based on the concept of balanced brightness, as well as sufficient light, over the entire work area. Benefits are listed as better workmanship, faster output, reduced spoilage, fewer accidents, and improved employee morale. Single copies of this bulletin are available by writing the Inquiry Bureau, General Electric Company, Nela Park, Cleveland 12, Ohio.

(*Continued on page 72A*)

(*Continued from page 70A*)

Calrod Heaters. The application of Calrod heaters by machinery manufacturers is described in 14 case histories in a bulletin designated as *GEA-5866*. The 16-page 2-color bulletin employs 50 photographs to tell how original equipment manufacturers have made new or improved machines using "built-in" electric heat from Calrod heaters. The case histories are grouped by the following applications: heating surfaces, melting soft metals, radiant heat, heating liquids, and heating process air. Copies are available from the General Electric Company, Schenectady 5, N. Y.

Microwave Information. Economic aspects of multichannel operation of telephone and telegraph circuits over microwave radio links are emphasized in the Lenkurt Bulletin *72A-P16*, "Microwave in the Telephone Toll Plant." Among the subjects discussed in this publication are the investment required for microwave equipment, the revenue possibilities which microwave provides, and the way in which the use of microwave affects such problems as future system growth, reliability of service, and installation and maintenance procedures. Copies of this bulletin are available from the Lenkurt Electric Company, County Road, San Carlos, Calif.

Optical Gauging. A 12-page booklet published by the Kodak Company describes advanced methods of optical gauging to cut inspection and tool-room costs. The booklet illustrates the uses of special fixtures and charts to inspect to close tolerances large parts, complex shapes, and blind holes and recesses using contour projection. The booklet is obtainable free on request from the Industrial Optical Division, Eastman Kodak Company, 343 State Street, Rochester 4, N. Y.

Exterior Lighting. Exterior incandescent lanterns for churches, hospitals, hotels, schools, institutions, and public and commercial buildings are illustrated and described with sketches and specifications in 16-page folio *L-50*. Included in the folio are fixtures of cast bronze, cast aluminum, and heavy gauge copper, with many kinds of glass shielding. Copies of the folio are available from Gruber Lighting, 125 South First Street, Brooklyn 11, N. Y.

Cleaning of Electric Motors. Fine Organics, Inc., offers a highly informative 4-page bulletin on how to clean motors and generators with emphasis on the use of safer solvents, both from the standpoints of fire and health hazards. This is a reprint of a Safety Maintenance and Production article and contains many safety suggestions as well as detailed information on several types of blended solvents suitable for electrical maintenance. Write Fine Organics, Inc., Department IM, 211 East 19th Street, New York 3, N. Y.

HIGHLIGHTS.....

Redefinition of Membership Grades. As a result of recent amendments to the AIEE Constitution, the requirements for the various grades of AIEE membership have been redefined. This brief review is presented as an aid to those who may not have followed these changes in detail (*pages 281–4*).

The Equipment Manufacturer and Power Education. Opportunities that the manufacturer of power equipment has to offer young engineers and the reasons for the lack of interest in power education are discussed. Current developments in power generation, transmission, and distribution provide stimulating professional work for young men choosing that field (*pages 295–7*).

Why Options Anyway? A discussion of options in curricula also must concern itself with the function of such options in helping achieve the broad objectives of engineering education. The reasons for such breakdowns in curricula and possible alternatives are described (*pages 305–06*).

Field Surge Testing of High-Voltage Lines. The objectives of this artificial lightning test program now being conducted to obtain extra-high-voltage data are presented together with a brief description of the equipment being used (*pages 287–8*).

New Unity Plan Proposal. In this article, members of the Pittsfield General Electric Engineers Association present their plans for a Unity Organization which would include all members of the engineering profession, with the maximum of participation by the members at the local level in shaping policies (*pages 349–51*).

News Index

A New Universal Right-Hand Rule. This one new rule supersedes both of Fleming's right-hand rules, dated nearly 70 years ago. With it you can predict the direction of the force on a conductor and the direction of a generated electromotive force (*pages 346–9*).

Electronic Instruments for Production Testing of Camera Shutters. A brief description of some of the instruments used by one camera manufacturing company for the quality control and testing of its camera shutters is presented in this article (*pages 336–40*).

Dynamic Braking on Diesel-Electric Locomotives. Originally intended as a means of controlling both passenger- and freight-train speed on mountain grades, dynamic braking has been refined to the point where it is increasingly used for controlling freight-train speed in relatively level territory. A discussion of the control equipment will be found in this issue (*pages 300–05*).

Automatic Cruise-Control Computer for Long-Range Aircraft. This article presents a qualitative discussion of present manual cruise-control technique and describes a proposed cruise-control computer for long-range military aircraft. A mechanization of the computer is described together with its operation and a comparison of the automatic system with manual techniques given (*pages 309–12*).

New High-Voltage Outdoor Load-Interrupter Switch. This unit is designed to make available at transmission voltages a dependable and economical outdoor circuit interrupter. It is completely self-contained, requiring no external gas supply or other auxiliary apparatus for operation, and the switch is long-lived as shown by numerous tests (*pages 324–7*).

UNIVAC's Predictions of the National Election Results. The computer made its debut to the world's largest television audience for this purpose. Both the mathematical theory which had to be developed in advance and the actual setup to process the data on election night are covered here (*pages 291–3*).

India's Larger High-Voltage Laboratory. It is located at Bangalore and will be instrumental in furthering research, the training of personnel, and in conducting electrical tests both for science and industry. The equipment is described as well as the kinds of experimentation already under way (*pages 320–4*).

The Deductive Method in the Physical Sciences. The narrower strictly inductive approach to science is deprecated as ignoring some of the theoretical or ideal elements necessary to true scientific understanding. Sciences are classified as correlational and theoretical. The latter type utilizes both induction and deduction (*pages 284–6*).

Electrostatic Safety for Hospital Operating Rooms. A description of how static electricity is generated is followed by a discussion of safety factors in operating rooms. Conductive floors and electrostatic hazard alarms are given considerable attention (*pages 329–34*).

Maintenance of Electric Equipment in Modern Aircraft. The design of electric equipment and its location in an airplane determines whether its maintenance is easy or difficult. Some of the factors involved in this important activity will be found in this article by a maintenance engineer (*pages 312–17*).

Improving Gas-Tube Grid-Circuit Reliability. Some designers have felt that thyratrons are to a certain extent unpredictable in performance and so have not used them as much as possible. If more engineering attention were given to this tube's grid circuit, it is felt that better results would be obtained (*pages 341–6*).

Bimonthly Publications

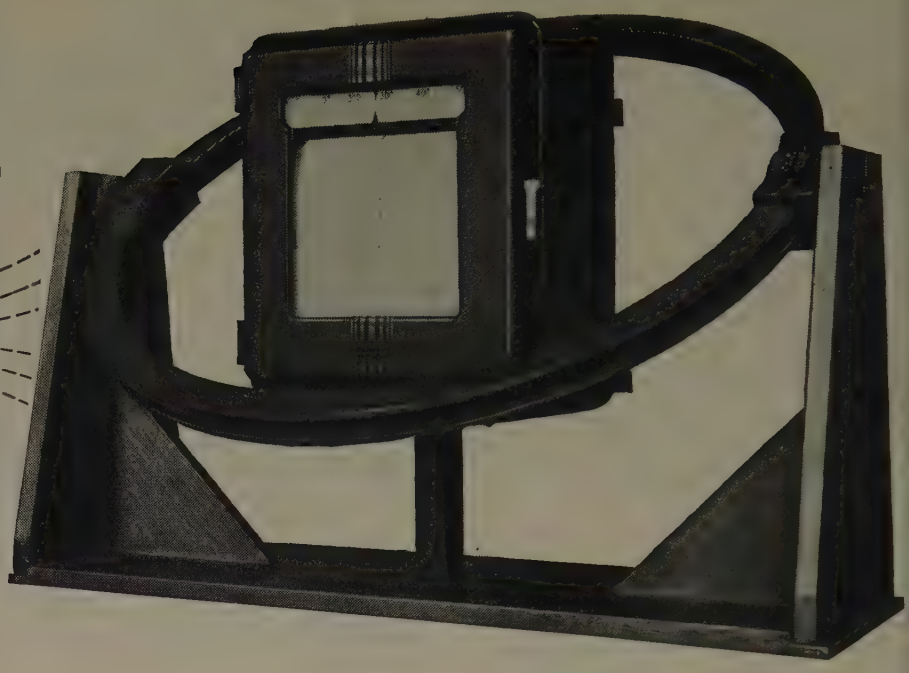
The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers (exclusive of ACO's) presented at General and District Meetings. The publications are on an annual subscription basis. In consideration of payment of dues, members may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. H. H. Henline, Secretary, 33 West 39th Street, New York 18, N. Y.

ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office 20th & Northampton Streets, Easton, Pa. Editorial and advertising offices 500 Fifth Avenue, New York 36, N. Y. Subscription $12 per year plus extra postage charge to all countries to which the second-class postage rate does not apply; single copy $1.50. Entered as second-class matter at the Post Office, Easton, Pa., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925.
April 1953, Vol. 72, No. 4. Number of copies of this issue 55,600

Here's how L&N engineers verify Speedomax resistance to stray electrical fields. The ring is a Helmholtz coil, adjustable for a wide variety of field effects.

Speedomax is engineered for FIELD service



● Built into every Speedomax recorder and controller is a high degree of indifference to stray electrical fields. And this is one of its most useful characteristics in almost any job. It means that you can install a Speedomax near a big motor, power line or X-Ray machine—any electrical equipment in fact—and you'll probably see no effect at all from surrounding electronic noise and "junk".

The reason for this indifference to stray fields goes back through the adjustment, building and design of the instrument, to its basic engineering. Speedomax has an *electronically-clean measuring circuit*, as well as clean signal and amplifier circuits.

This clean design includes a bifilar-effect slidewire, to eliminate any objectionable inductance at that point. It includes our "no-moving parts" trolley contact on the slidewire, which eliminates pigtails and their variable inductances. It includes use of a Mumetal slidewire shield where desirable, instead of less expensive but lower-permeability aluminum. And it includes a lot of just downright meticulous detailing, such as carefully engineered wiring and input filtering, plus ingenious shielding where required.

These and other precautions eliminate out-of-phase components in the supply to the amplifier. The latter therefore doesn't "load"; hence sends the correct amount of correct-phase power to the balancing motor. With ample power, the motor's recording and control action is snappy and accurate.

Our Catalog ND46(1) and Technical Publication ND46(1) tell the story. Write our nearest office or 4962 Stenton Avenue, Philadelphia 44, Pa.

Power engineers and users find that Speedomax instrument operation is not affected by the stray fields created by nearby power lines, motors, telemetering equipment and so on.

PHOTO COURTESY CINCINNATI GAS & ELECTRIC CO.

PHOTO COURTESY IOWA-ILLINOIS GAS & ELECTRIC CO.

Jrl Ad ND46(10b)

LEEDS NORTHRUP

instruments *automatic controls • furnaces*

Specify SQUARE D Motor Starters for 3 Important Reasons

Easy to Wire!

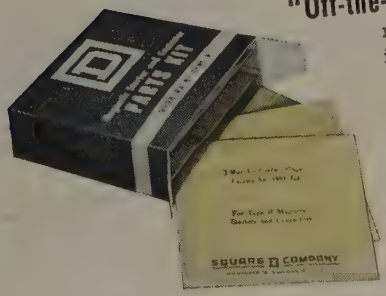
Plenty of wiring space.
Handy solderless terminals.

Easy to Get At!

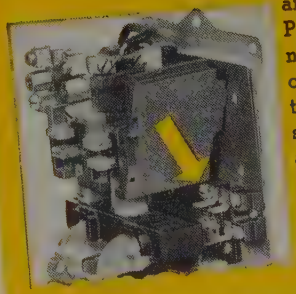
Coils, contacts or overload relays can be changed in no time at all—without disturbing external connections.

Easy to Live With!

Straight line guided motion minimizes wear; large silver alloy contacts insure trouble-free electrical performance.



"Off-the-Shelf" Parts Kits make normal maintenance easier than ever. Each kit contains parts necessary to replace all load contacts and finger springs. An illustrated service bulletin is enclosed to provide quick parts identification and complete installation instructions.



ELECTRICAL INTERLOCKS are available in kit form. Practically any necessary number or arrangement of extra interlock contacts can be added to any standard starter. Sizes 2 and 3 starters have new front-of-panel mounting interlocks for faster, easier installation.
(See cutaway at left)

Write for Bulletin 8536.
Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin.

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

SQUARE D COMPANY

1903 • 50 YEARS OF DESIGN LEADERSHIP • 1953

INDUSTRIAL NOTES ....

General Electric Notes. Retirement of H. Herbert Magdsick, for the past 23 years executive engineer in the Application Engineering Department of General Electric's Lamp Division at Nela Park, Cleveland, Ohio, has been announced. Mr. Magdsick's retirement follows more than 42 years of service with the company.

Leland D. Whitescarver has been appointed Manager of Marketing for the Medium Steam Turbine, Generator and Gear Department in Schenectady, N. Y.

A $400,000 modernization program has been launched at the Bleeker Street plant in Utica, N. Y. The program, according to the plant manager, Frank Greene, Jr., will involve the installation of machinery to be used in the manufacture of Polystyrene cabinets for clock radios and table model radios.

The Small and Medium Motor Department has been discontinued and its operation has been decentralized into three new product organizations. A divisional marketing department also was established to facilitate a unified approach to all division marketing policies. The four new departmental organizations and their managers are: Marketing Department, Walker H. Henry, manager; Medium Induction Motor Department, Olaf F. Vea, general manager; Direct Current Motor and Generator Planning Study, Oscar L. Dunn, manager; and Synchronous and Specialty Motor and Generator Department, Fred B. Hornby, general manager. Headquarters for the first three organizations will be at Schenectady, and the Synchronous and Specialty Motor and Generator Department will be located at the Lynn (Mass.) River Works.

Allis-Chalmers News. Appointment of Arthur F. Erwin and Edward F. Brill as manager and chief engineer, respectively, of Allis-Chalmers atomic power section in Milwaukee, Wis., has been announced. Mr. Erwin joined Allis-Chalmers in 1935 and has been assistant manager of the atomic power section since 1951. Mr. Brill has been associated with the company since 1941 and in 1949 was transferred to the atomic power section and in 1952 was named engineer-in-charge.

J. T. Graham, a resident representative in the Jacksonville, Fla., office of Allis-Chalmers general machinery division since 1948, has been advanced to manager there. At the same time it was announced by D. S. Kerr, manager of the company's Southeast Region, that Jacksonville is now a branch office of the Tampa district.

William L. Manly, for the last several years special assistant to C. W. Schweers, vice-president and director of sales at the General Machinery Division in Milwaukee, Wis., has been named assistant director of sales of the division.

New RCA Appointment. Election of L. W. Teegarden as executive vice-president of the Radio Corporation of America has been announced. Mr. Teegarden, a pioneer merchandiser, has been active in the electrical and electronics industries for many years. Prior to assuming his new post, Mr. Teegarden was vice-president in charge of Technical Products of the RCA Victor Division. In this position, he supervised the activities of both the Engineering Products Department and of the Tube Department.

Westinghouse News. Carroll B. Dick has been appointed manager of the Westinghouse Electric Micarta Division. Mr. Dick, formerly works manager of the Westinghouse Electric Appliance Division plant at East Springfield, Mass., will succeed E. R. Perry, who has resigned to accept a position with an eastern firm.

P. C. Smith, manager of the Transportation and Generator Division at East Pittsburgh, Pa., has appointed W. R. Sugg, Jr., assistant manager of the Division, and G. A. Moore, manager of manufacturing.

Appointment of two Westinghouse Electronic Tube Division sales executives to newly created sales posts was announced. John J. Doyle, a 25-year man with Westinghouse, assumes the new post of manager of renewal tube sales, and James L. Brown, a veteran of 16 years' electronic tube sales experience, becomes manager of equipment tube sales.

Electric Service Manufacturing Personnel Changes. Warren Erbe, St. Louis, Mo., sales representative for Electric Service Manufacturing Company, has been named district manager of that office.

Ray Gawthrop, of the Philadelphia, Pa., office has been transferred to the Detroit, Mich., office.

Research Organization Formed. Olin Industries, Inc., has announced the formation of a general research organization that will conduct basic research and work with all eight Olin manufacturing divisions on long-range and specialized research problems and will co-ordinate the efforts of the company's various divisional research departments. Laboratories already have been established at New Haven, Conn., and East Alton, Ill., staffed by a total of 45 scientists. Dr. Herman Bruson, one of the country's top Polymer chemists and holder of 280 separate United States patents on chemical products and processes, has been named head of Organic Chemical Research.

America Lava Notes. The American Lava Corporation, Chattanooga, Tenn., announced the election of G. E. Richter as vice-president–Director of Sales, and the appointments of James L. Ridkin as Sales Manager, Eastern Division, and

(*Continued on page 22A*)

Rome Aluminum Self-Supporting Service Drop Cable is regularly supplied with two RoPrene (Neoprene) insulated power conductors of solid aluminum, spiralled around a bare neutral messenger of ACSR (aluminum conductor steel reinforced). This time-proven construction provides high strength, simplicity of installation.

Rome Aluminum Line Wire is available with covering of RoPrene (Neoprene) or RoLene (polyethylene) as specified. Here is low cost Line Wire having ease of handling, as well as long, non-festooning service life. Uniformly small diameters provide neater appearance, plus reduced wind and ice loading.

It Costs Less to Buy the Best

Rome ALUMINUM

ROME CABLE CORPORATION, ROME, N.Y., AND TORRANCE, CALIF.

(*Continued from page 18A*)

E. Dudley Bell as Sales Manager, Western Division.

A new Syracuse, N. Y., office has been opened at 330 Arlington Avenue, Syracuse 7. Gilbert Reimann is their representative in charge.

New Appointment. The Board of Directors of Rickard and Company, Inc., has announced the election of Howard H. Sharman as executive vice-president.

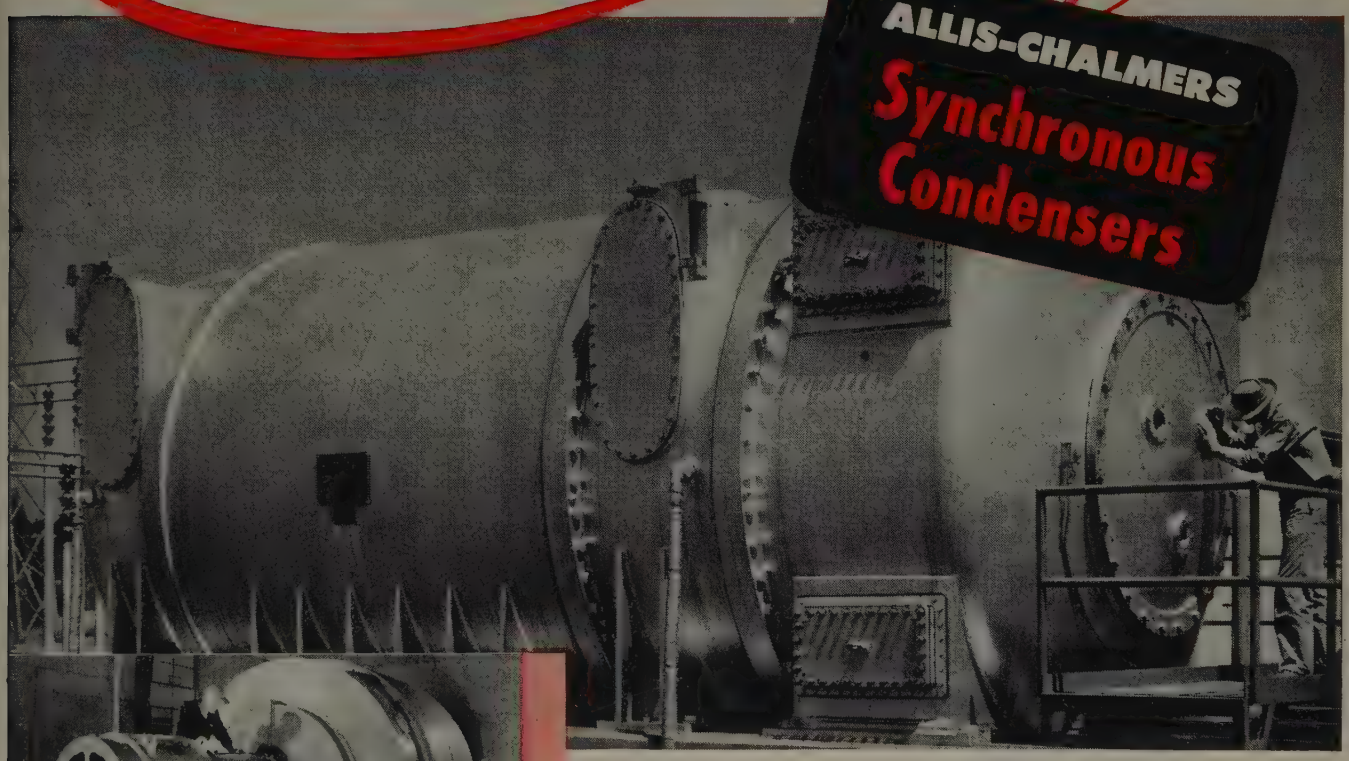
NEW PRODUCTS • •

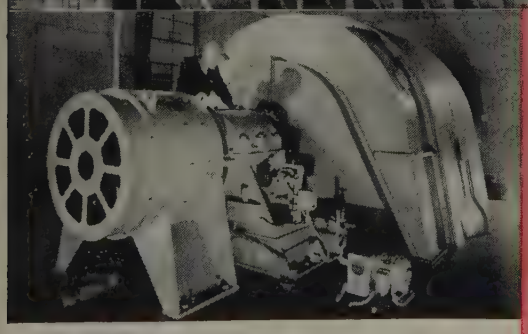
Meter for Testing Secondary Voltages. A way to test accurately the secondary voltage of synchros and other circuits requiring meter-current corrections is provided by the model *105* Meter Matcher. It is a highly accurate power frequency amplifier. When used in conjunction with a voltmeter or wattmeter, it practically eliminates the errors previously caused by meter currents. In a typical application, the secondary voltage of synchros under test varies from 40 to 90 volts. A 1/4-per-cent accuracy electrodynamometer voltmeter with a resistance of approximately 3,000 ohms is used. To prevent loading the synchro, at least 100,000 ohms must be across the secondary, hence the Meter Matcher. Its input is connected to the synchro, its output to the voltmeter. Input impedance of the Meter Matcher requires less than 150 microamperes from the test circuit. Its output provides the 0.05 to 0.07 ampere which most accurate dynamometer instruments require for full-scale deflection. Connections for 15-, 75-, 150-, 300-, and 600-volt inputs are provided, with an output of 150 volts in each case. This gives a 150-volt voltmeter or wattmeter an effective range of full-scale voltages from 15 to 600 volts. Over-all accuracy of the Meter Matcher is such that less than 0.15-per-cent error is added to measurements. In addition to the testing of synchros, the amplifier has numerous uses where exceptional accuracy is required. These include measuring both linear and nonlinear circuits when meter currents introduce errors not easily computed, increasing meter sensitivities, and as a signal amplifier. Full details on request to Keithley Instruments, 3868 Carnegie Avenue, Cleveland 15, Ohio.

Sudden-Pressure Relay. A new sudden-pressure relay that protects power transformers from internal faults is available from the Westinghouse Electric Corporation. Operating on rate of change of pressure, it is not affected by pressure changes common to transformer operation. In addition, it is more sensitive to small faults, and is quicker to operate when large faults occur than were previous pressure devices. When an arc breaks

(*Continued on page 28A*)

Better than Rebuilding Transmission Lines





Pacific Coast system uses 50,000-kva hydrogen-cooled condenser (top view), and 20,000-kva air-cooled unit (bottom view).

Besides minimizing losses, hydrogen cooling results in a design suited to outdoor operation. Air-cooled units can also be built for outdoor use, and for industrial power-factor-correction applications.

Regulex amplifier control, which acts as both regulator and pilot exciter, is available for all synchronous condenser ratings.

Regulex is an Allis-Chalmers trademark.

FOR WIDESPREAD power systems, synchronous condensers can frequently be used in place of added or larger transmission lines. This is possible because, by supplying reactive kva, they assure efficient use of power lines.

But condensers can do more than just cut conductor requirements. They also provide voltage regulation on a wholesale scale, and furnish rotating inertia for improved system stability.

Custom-engineered to fill system requirements and to fit installation conditions, Allis-Chalmers synchronous condensers can help you hold down transmission costs. For more information on units for utility or industrial applications, call in your A-C representative, or write for Bulletin 05B7285. Allis-Chalmers, Milwaukee 1, Wisconsin.

A-3960

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

(*Continued from page 22A*)

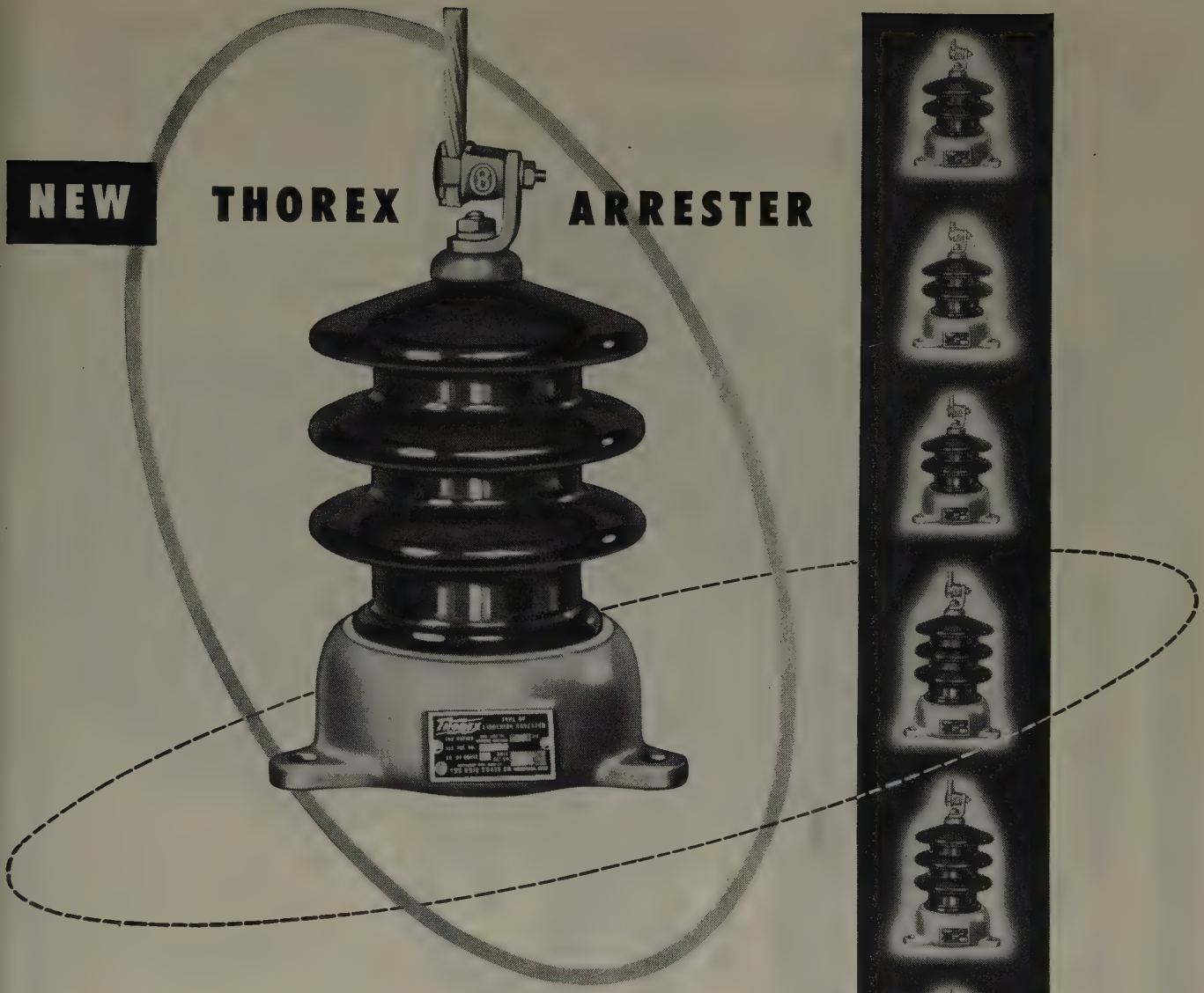
down transformer oil, the increased gas pressure is transmitted from the transformer case to the relay device through a small tube. The pressure differential is throttled through the tube and actuates a bellows that is sensitive to a rate of rise of pressure as low as approximately 1 ounce per square inch per second. A microswitch connected to the bellows either will sound an alarm or trip a circuit breaker to take the transformer out of service. A manually operated momentary off switch is provided to reset the relay. Faults that produce rates of rise of pressure of 10 to 15 pounds per square inch per second cause the relay to operate in 2 or 3 cycles. Rates of 40 pounds per square inch per second cause operation within 1/2 cycle. For further information, write Westinghouse Electric Corporation, P. O. Box 2099, Pittsburgh, Pa.

Float Switch. The Revere float switch was designed originally as an aircraft high-level fuel-control instrument, providing automatic cutoff control for single-point high-pressure fueling and air-to-air refueling. It is suited also for many industrial applications where fluid level control is important. The instrument is available in many different configurations, some of which include relays to handle heavy electric loads. Others are designed for complete submersion in fluids. The Revere float switches can be supplied with single level or dual level systems. Each system provides an electric signal through a magnetically operated switch, which is hermetically sealed in a glass tube. The actuating alnico magnet is incorporated in the counter weight of a statically balanced float assembly. The actuating magnet, positioned by the float, opens or closes the switch at predetermined levels which are set precisely at the factory. For complete information write Revere Corporation of America, Department 60, Wallingford, Conn.

Comparison Bridge. Accurate and simple production tests are possible on the new general-purpose type *1604-A* comparison bridge developed by General Radio Company, Cambridge, Mass. With a basic accuracy of 0.1 per cent, the bridge can be used for direct comparison of resistors, capacitors, and inductors over the wide impedance range of about 2 ohms to 20 megohms. Two impedance-deviation ranges, ± 5 per cent and ± 20 per cent, are provided. Dissipation-factor or storage-factor differences are indicated also. The bridge is completely self-contained with a cathode-ray visual detector and an oscillator operating at either 1 kc or 5 kc. Operation is from the a-c line. The point at which the bridge is grounded can be switched, so that measurements can be made with the unknown either grounded or ungrounded. The primary application for the comparison bridge is that of sorting components to a given tolerance. The standard to be used need not be a precision standard

(*Continued on page 34A*)

NEW **THOREX** **ARRESTER**



for close-clearance mounting!

Retaining all of the excellent protective characteristics of the Type GP Thorex lightning arrester, the new GPA Model permits a radical reduction of mounting clearance dimensions. This makes for easier installation in the confined spaces of unit substations or other restricted enclosures. When mounted indoors within enclosed switch gear, this arrester may be installed in upright, horizontal, or inverted position, thus permitting full advantage to be taken of its close spacing possibilities. Universally adjustable terminals allow for any direction of lead.

Restricted clearance in the new Thorex GPA is obtained by all-porcelain top construction, where the energized element is confined to a small central stud and terminal, thus gaining over six inches of radius when compared to the arrester employing a top casting energized at line potential.

Another improvement in the new Type GPA Thorex is a closer graduation of line-to-ground, power frequency voltage ratings. This arrester is now available in 3, 4.5, 6, 7.5, 9, 12 and 15-kv values.

Other than clearance, the Model GPA is identical to the metal-top Thorex line -- offering you a high level of lightning protection at low cost.

Ohio Brass

MANSFIELD **OHIO, U.S.A.**

4386-H

(*Continued from page 28A*)

but can be a component which has been independently measured. An offset zero is provided within the bridge so that an accurate standard is not necessary.

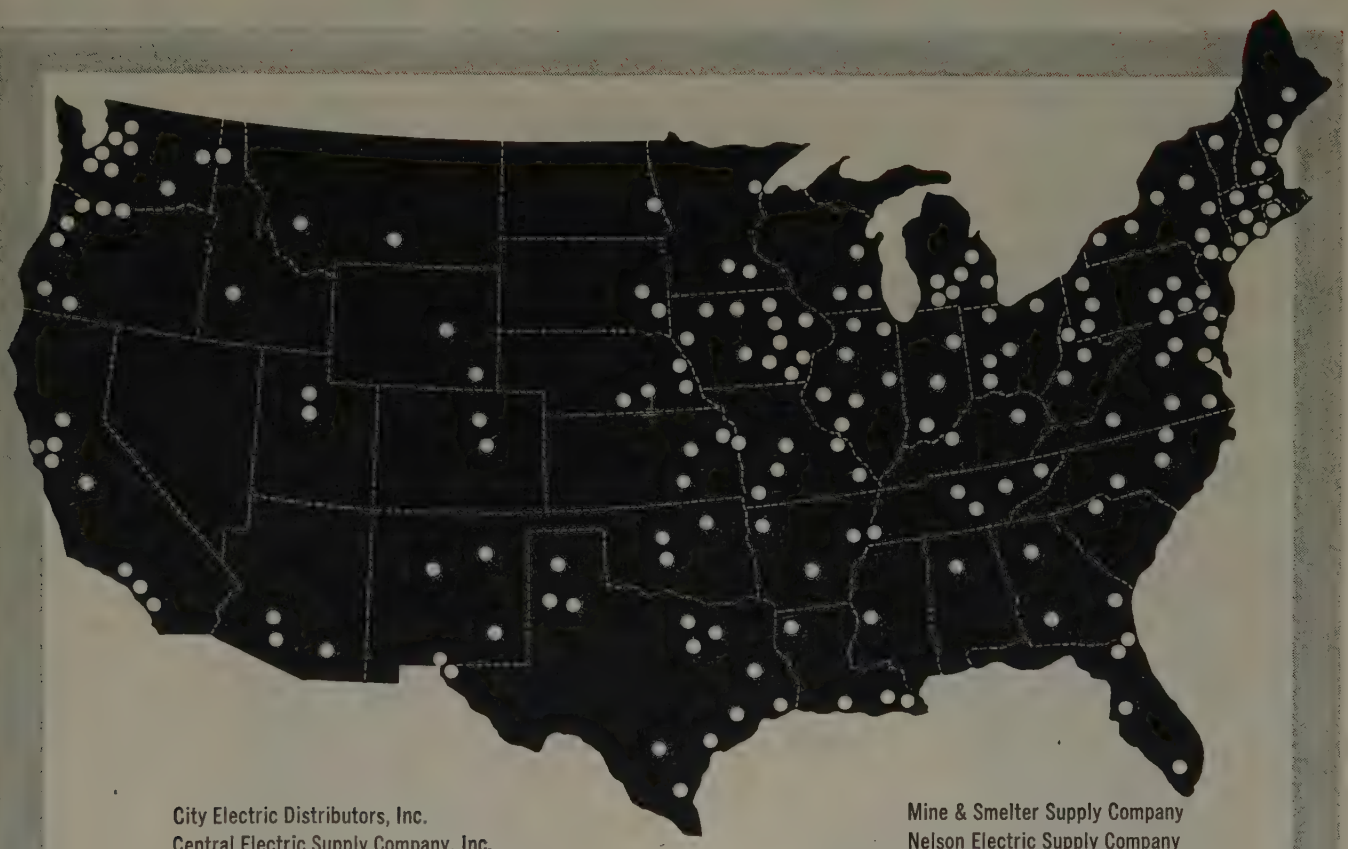
Multipurpose Signal Generator. Receiver and amplifier gain, selectivity, sensitivity, and image rejection are a few of the ultrahigh-frequency and television measurements made with a new signal generator announced by Hewlett-Packard Company. The equipment is also useful as a power source for driving bridges, slotted lines, antennas, and filter networks. This master oscillator power generator is designated model *612A*. It offers continuous coverage between 450 and 1,200 megacycles. Frequency and output are set directly and read on large dials. No charts or interpolation are necessary. Maximum output is 0.5 volt into 50 ohms throughout the frequency range. The instrument offers broad-band modulation up to 5 megacycles and has low incidental frequency modulation. It can be modulated internally or externally, amplitude modulated or pulse modulated with good radio-frequency pulses 0.2 microsecond or longer. Pulse modulation may be applied to the amplifier or direct to the oscillator section when high on-off signal ratios are desired. For further information, write Hewlett-Packard Company, 395 Page Mill Road, Palo Alto, Calif.

Miniature Capacitor. The Hammarlund Manufacturing Company, New York, N. Y., has developed a miniature variable capacitor, type *MAC*. The *MAC* provides the low minimum capacity essential for use as a trimmer in the very-high-frequency range. Its silicone-treated steatite base is only 3/4 inch by 5/8 inch. The rotor and stator are soldered assemblies of brass which are later silver plated for low losses. A silver-plated beryllium-copper wiper rotor contact is used. Rotor and stator terminals are positioned to permit short leads. The threaded bearing is provided with flat sides to permit single hole mounting without turning. The new units are available to fulfill capacity requirements between 1.4 and 19.6 micromicrofarads.

Recorder Amplifier. A new electronic device, the model *R3* recorder amplifier, has been developed at the Goodyear Aircraft Corporation, Akron, Ohio. The amplifier is a lightweight portable unit designed especially to plot the solutions to small problems where the use of a large recorder would be impractical. The *R3* works with standard direct-inking or hot-wire recording galvanometers. Its accuracy is limited only by the nonlinearities of the galvanometers. Typical units are guaranted to be within 2 to 5 per cent. The *R3* records two channels of information within a frequency range essentially flat from direct current to 100 cycles. The amplifier unit supplies its own power and has its own voltage regulator. Ampli-

(*Continued on page 52A*)

THERE'S A KAISER ALUMINUM EC DISTRIBUTOR CONVENIENTLY LOCATED TO SERVE YOU



City Electric Distributors, Inc.
Central Electric Supply Company, Inc.
Capital Electric Supply
Crescent Electric Supply Co.
Dauphin Electrical Supplies Company
Dutton-Lainson Company
Eoff Electric Company
Electrical & Mechanical Supply Corp.
Florida Electric Supply, Inc.
George H. Wahn Company

General Electric Supply Corporation
Hunzicker Brothers
Interstate Electric Co. of Shreveport, Inc.
Line Material Company
Maydwell & Hartzell, Inc.

Mine & Smelter Supply Company
Nelson Electric Supply Company
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Take advantage of the many services offered by your nearby Kaiser Aluminum ECDistributor. Here are a few:

- He has available large stocks of Kaiser Aluminum Conductor.
- He insures fast delivery to help reduce your inventory.
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- He provides top-notch engineering services.
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NEOPRENE AND POLYETHYLENE COVERED CONDUCTOR, SOLID AND STRANDED • SELF-SUPPORTING TRIPLEX CABLE • ACSR ALL ALUMINUM CONDUCTOR

Kaiser Aluminum

setting the pace—in growth, quality and service

(*Continued from page 34A*)

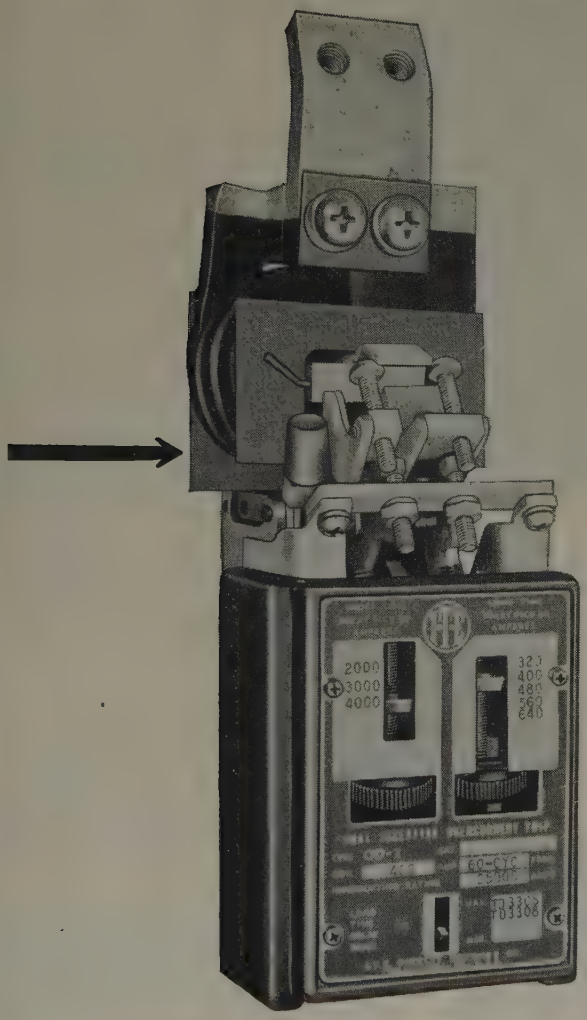
fier channels have a high input impedance of 2.5 megohms on the 0.01- to 0.1-volt-per-millimeter range and greater than 10 megohms on all other ranges. Limiting circuits in the amplifier protect galvanometer movements and keep pens in their pivots when an overload is applied. The balance poteniometer may be used to adjust the pen on the recorder chart electrically and to balance out any input d-c signal for greater amplification of the a-c component. Power requirements are 105 to 125 volts, 60 cycles, single phase, and about 150 watts.

Circuit Breaker. Square D has announced a new circuit breaker, the *XO*, for lighting and general-purpose loads. Operating features include quick-made, quick-break operating mechanism to eliminate teasing of contacts; positive operation assured by direct action of the handle on the blade with no intermediate links or couplings; automatic relatching which eliminates complicated restoration of service; ambient compensation to prevent nuisance tripping due to increased temperatures; plug-in mounting for speedy installation and flexibility; shock resistance which reduces needless tripping due to vibration; and thermal-magnetic protection for both moderate and extremely heavy overloads. A new approach has been used to prevent dangerous tampering. That is, 15- and 20-ampere single-pole circuit breakers are 1/2 inch wide while large capacity 30-, 40-, and 50-ampere ratings are 3/4 inch wide per pole and are only available in double-pole construction. Thus, it is impossible to interchange larger capacity circuit breakers with smaller rated units. The complete *XO* load center line, covering a range of from 1 to 32 circuits, is made up of only six basic boxes. Single-phase 3-wire, 3-phase 4-wire, main lugs and main circuit breakers, and general-purpose or raintight enclosures are available. Write Square D Company, 6060 Rivard Street, Detroit 11, Mich., for details.

Frequency and Modulation Meter. A frequency and modulation meter for use in the maintenance of 2-way radio systems has been announced by the General Electric Company's Electronics Division, Syracuse, N. Y. The meter, type *ST-13-A*, measures modulation swing and carrier frequency of frequency-modulation transmitters, and features both high and low radio-frequency output for receiver alignment. It is available with either one or two crystals, for servicing single- or 2-frequency systems, in both the low and medium and high bands. The meter is available with or without a crystal oven, and with crystal tolerances ranging from 0.0005 to 0.0025 per cent. The oven, available in two ratings, 38 and 75 degrees centigrade, is powered from any external 6-volt power supply. The meter is available in several models, each having different limits of operation. For further information write Department N-14, In-

(*Continued on page 58A*)

or shutdown?



Selective tripping on I-T-E Circuit Breakers isolates system faults, boosts system reliability

What selective tripping is

Selective tripping is the economical means for providing reliable electrical service with complete freedom from general interruption. With selective tripping, several circuit breakers may be used in series; yet on overcurrent or fault, *only* the faulted circuit is interrupted.

What it does

Consider the following cases for a typical low-voltage system:

Without selective tripping—the overloaded motor in the diagram at left could cause breakers C, B, D, and A to trip, shutting down a boiler, a plant, or an entire system. This *will* happen, if the system does not include circuit breakers equipped for selective tripping.

With selective tripping—only breaker C will trip. A motor saved, one circuit interrupted, while *the rest of the system continues to operate—unaffected.*

Consider I-T-E selective tripping for your system

In central stations, in manufacturing plants, in the processing industries—I-T-E selective tripping has saved in initial investment, boosted system reliability, and reduced breaker maintenance. If you're planning a new low-voltage switchboard application, investigate the advantages of direct-acting I-T-E trip devices.

I-T-E trip device is a compact circuit breaker component

Selective tripping in low-voltage systems is easily applied with I-T-E Circuit Breakers. The breakers are simply equipped with compact I-T-E *direct-acting dual-selective overcurrent trip devices.* No expensive current transformers, no relays, no added switchboard panels are required. The trip devices are fitted as an integral part of the breaker.

I-T-E

LOW-VOLTAGE SWITCHGEAR

I-T-E CIRCUIT BREAKER CO. • 19TH AND HAMILTON STS. • PHILADELPHIA 30, PA.

CANADIAN MFG. & SALES: EASTERN POWER DEVICES, LTD., TORONTO

(*Continued from page 52A*)

quiry Section, General Electric Compan Electronics Park, Syracuse, N. Y.

Events-Per-Unit-Time Meter. T Berkeley Events-Per-Unit-Time Me model *5558* is a high-speed electron counter combined with an accurate ti base to provide an instrument that au matically will count and display t number of events that occur during precise time interval. These events m be any mechanical, electrical, or optic occurrences that can be converted in changing voltages. The meter will cou events occurring either regularly or wi random distribution at rates of from to 1,000,000 events per second with accuracy of *1* one count. The result displayed on the illuminated numb panels of 6 Berkeley Decimal Counti Units and read directly in digital for The Events-Per-Unit-Time Meter co sists of an input circuit, an electron gate which is opened and closed by t oven crystal controlled time base, and series of electronic decade counting uni The Events, occurring at an unknov rate, are amplified and properly shap by the input circuit. These pulses a then passed through the electronic ga to the counting units. The gate is open by a signal from the time base and remai open for an accurately controlled interv of time and is closed by a second sign from the time base. The meter is man factured by Berkeley Scientific Divisi of Beckman Instruments, Inc., 2200 Wrig Avenue, Richmond, Calif.

D-C Train Power Supply. A 12-v d-c train power supply that eliminat the need for an a-c converter and incorp rates a plug-in vibrator cartridge capab of operating both transmitter and receiv has been developed by Federal Telepho and Radio Corporation, Clifton, N. Designed specifically for use in caboo installations, the power supply unit (ty *M322-1*) has been engineered to meet t adoption of the 12-volt d-c caboose electr system by American railroads. T *M322-1* circuit employs a heavy-du railroad-type plug-in vibrator with fu wave tube rectifiers, weighs 35 pound and has a temperature range of –30 to degrees centigrade. Nominal input volta is 12.6 volts direct current, while t output voltage is rated at 300 volts dire current at 110 milliamperes for the receiv and 300 volts direct current at 325 mil amperes for the transmitter.

Push-Button Oscillator. The Kroh Hite Instrument Company, 580 Mass chusetts Avenue, Cambridge, Mass., h announced a new Model *440-A* pus button oscillator designed for applicatio requiring very low distortion or extreme good frequency stability and resetabili It provides both sine waves and squa waves at any frequency between 0. cycles and 100 kc. For fine control

(*Continued on page 64A*)

What do YOU make that takes wire?

If you make sieves or staples, screws or screens—whatever you make that takes wire—we're pretty sure to have the kind of manufacturers wire you need. Round, flat, square . . . hard, soft, ductile . . . plain, tinned, or bright finished . . . carbon, alloy, or stainless. Altogether we produce over 400 different types of wire which are suitable for practically all everyday wire applications.

But, if you need a special kind of wire, we can supply that too. Our modern plant facilities enable us to draw wire to meet the exact specifications of a special order, and our trained metallurgists are always ready to assist you with any manufacturing problems you may have.

We've been in the wire-making business more than one hundred years, and all of our experience is at *your* service . . . to help you do an easier and better fabrication job.

If you make it of wire... make it of the best!

U·S·S AMERICAN MANUFACTURERS WIRE

AMERICAN MANUFACTURERS WIRE

AMERFINE—*High-quality fine wire.*

AMERSPRING—*music steel spring wire.*

AMERLOY—*alloy heading wire.*

AMERTEMP—*heavy-duty oil-tempered wire.*

AMERHEAD—*uniform heading wire.*

AMERSTITCH—*extra-tough metal stitching wire.*

USS TRADE MARK

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION, GENERAL OFFICES: CLEVELAND, OHIO

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS

TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

(*Continued from page 58A*)

frequency, three banks of 10 push-button switches are provided. An additional vernier control varies the frequency continuously by an amount equal to the increment between adjacent buttons of the third switch bank. Hum and distortion are attenuated when the setting of the calibrated logarithmic output level control is reduced and are maintained at a constant low percentage of the desired output signal. This instrument is suited for bridge measurements, tuned filter alignment, rapid spot frequency checks, and distortion measurement.

TRADE LITERATURE

Industrial X-Ray Catalogue. A buying guide for a complete and diversified line of accessories and supplies required for the industrial X-ray installation is available from the Westinghouse Electric Corporation. This 44-page illustrated catalogue is divided into four basic categories: (1) films and chemicals; (2) radiographic accessories; (3) darkroom accessories; and (4) viewing and filing equipment. For a copy of this catalogue, *404–000*, write on company letterhead to Westinghouse Electric Corporation, Section X, 2519 Wilkens Avenue, Baltimore 3, Md.

Composition of Industrial Metals. A metals chart, showing the compositions of all commonly used metals and alloys in industry, has been prepared by Sam Tour and Company, Inc., New York, N. Y. The chart lists the constituent elements and the percentage composition ranges for 60 different classes or types of metals arranged in the following groupings: light metals, irons, steels, cobalts, nickels, coppers, white metals, precious metals, heavy metals, and special-purpose metals. Also shown is the atomic number and specific gravity of each of the 48 elements commonly encountered in industrial metals. A 2-page explanation accompanies the chart, describing the purpose of the chart and giving useful definitions of various types of metals. Copies may be obtained upon request to Sam Tour and Company, Inc., 44 Trinity Place, New York 6, N. Y.

Viking Catalogue. A new 16-page catalogue of Viking Electric, 1061 Ingraham Street, Los Angeles 17, Calif., has been completed. This loose-leaf catalogue gives engineering specifications and templates of miniature connectors, terminal boards, thermocouple connectors, and printed circuit hardware. Write to Department M, Viking Electric, 1061 Ingraham Street, Los Angeles 17, Calif., for a free copy.

Industrial Temperature-Control Manual. The Partlow Corporation, New Hartford, N. Y., has published a new edition of its

(*Continued on page 66A*)

OUTDOOR INSTALLATIONS of JKP-0 are made without housing or cross-arms—due to low-cost, rugged butyl insulation-casing.

INDOOR VIEW shows insertion of two primary cables in two inch window. Secondary terminals on top permit close mounting.

New G-E Indoor-Outdoor Current Transformer Type JKP-0 Is Now Available from Stock

The new JKP-0 current transformer, with exclusive butyl-insulation and indoor-outdoor features, is available from stock.

4 WAYS THE JKP-0 SAVES

1. STOCKING COSTS REDUCED: Standardizing on the JKP-0 cuts costs by reducing stock requirements. This versatile new transformer replaces 5 G-E types.

2. MAINTENANCE IS REDUCED: JKP-0 transformers will not corrode and need no painting—due to rugged butyl-molded construction.

3. INSTALLATION COST IS LESS: The JKP-0 does not require elaborate arrangements of cross-arms, hanger, connections, etc.—and the amount of wiring is reduced.

4. INITIAL COST IS LESS: The JKP-0 sells for less than most of the conventional types it replaces.

FOUR RATINGS AVAILABLE

Four current ratings are available in the Type JKP-0. They are 200:5, 400:5, 600:5, and 800:5 amperes. These ratings are obtained by passing the line conductor once through the primary window. Additional ratings can be obtained by looping the primary conductor two or more times through the easily-accessible window.

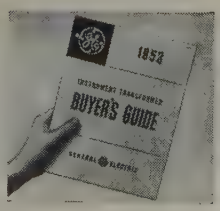
FOR MORE INFORMATION

Contact your local G-E representative today, or write for Bulletin GEA-5874 to Section 604-37, General Electric Company, Schenectady 5, New York.

You can put your confidence in—

GENERAL ELECTRIC

1953 EDITION NOW AVAILABLE



FREE—SEND TODAY

General Electric Company, Sec. 604-37
Schenectady 5, New York

Please rush my copy of the new 1953 INSTRUMENT TRANSFORMER BUYER'S GUIDE (GEA-4626).

( ) Planning immediate project

( ) Reference

Name.....

Position.....

Company.....

Street.....

City..... **State**.....

(*Continued from page 64A*)

manual, "The Design and Process Engineers Guide to Industrial Temperature Measurement and Control." This 24-page manual, available without charge to process engineers, plant managers, design engineers, and heating engineers, presents the basic principles of industrial temperature control. It defines different types of control systems and distinguishes between them so that the engineer can select the type most suited to a particular application. The manual discusses the eight ways of responding to temperature; the five ways of putting that response to work; and the nine basic Partlow instrument types. Typical control circuits and piping system arrangements, as well as the ranges and calibrations of scales and dials, are presented diagramatically. Copies of the manual, *101*, may be obtained from any Partlow representative or the factory.

Magnetic Motor Starters. The Arrow-Hart and Hegeman Electric Company, Hartford, Conn., has announced the availability of an 8-page folder describing its type *RA-V* magnetic motor starters with vertical overloads below contactor. The right-angle mechanism of type *RA-V* combines small size and light weight with added dependability. This combination provides savings in four ways: smaller, lower-cost condulets; faster, easier installation; reduced size and cost of mounting racks; and lower building costs and space requirements. The folder is fully illustrated and includes design features, size and weight data, and other information of interest to the engineer. It is available from the manufacturer, The Arrow-Hart and Hegeman Electric Company, 103 Hawthorn Street, Hartford 6, Conn.

Automotive Welding Repair Manual. Designed primarily as an aid to salvage of all truck and car equipment is a manual, "Truck and Car Fleet Maintenance and Repair Welding Manual," offered free of charge by the Eutectic Welding Alloys Corporation, Flushing, N. Y. Over 86 step-by-step photographs, plus 25 diagrams and charts, in this 56-page book illustrate money-saving ways to add years of service life to any automotive vehicle. Contents include repair of all stationary and operative parts grouped under these major headings: salvaging truck and automotive castings; repairing functional and mechanical parts; saving cracked and damaged body parts; salvaging ornaments, accessories, and auxiliary equipment. Welding, brazing, and soldering techniques are detailed for all steels, cast iron, cast and sheet aluminum, brass, bronze and copper, zinc die cast, magnesium, monel, and nickel. Repairs on motor, head, block and manifold, cooling and heating systems, bumpers, transmission gears and shafts, frame and spring, body, fender, shaft overlays, steering and suspension links, and others are discussed. Requests for copies should be addressed to Department P, Eutectic Welding Alloys Corporation, 40–40 172d Street, Flushing 58, N. Y.

HIGHLIGHTS.....

Of Current Interest. Among new developments described this month is the newest and most powerful IBM high-speed electronic calculator, the *701;* an internal magnetic focus gun for television; an automatic teletype system to handle air-line communications; and a high-power, efficient low-loss coaxial cable known as Styroflex (*pages 464–8*).

Television Coverage of the National Political Conventions. Nineteen video channels were needed for the complete coverage of the 1952 nominating conventions in Chicago. Some of the problems these channels entailed and how they were solved by telephone engineers will be found in this article (*pages 383–9*).

Management Development. Management has realized that it should have a planned approach to this problem so that the development of management people can be accelerated and proceed on a uniform basis through the organization. A general outline of basic steps and an example of a development program are presented (*pages 379–82*).

Power Connectors for Outdoor Use With Aluminum Conductors. The objectives of the present investigation are outlined together with the test procedure and an evaluation of the results. However, it is pointed out that the conclusions apply specifically to the connector design tested under heat-cycling conditions in a humid atmosphere (*pages 393–7*).

Outstanding Young Electrical Engineers. During the period 1936–51, some 259 young Americans have been candidates for the Recognition of Outstanding Young Electrical Engineers award offered annually by Eta Kappa Nu. An analysis of the records of these young men indicates some of the considerations which go into the making of a successful engineer (*pages 399–404*).

The Role of the Supervisor in Safety Work. An accident prevention program cannot be successful without good supervision. Obligations and responsibilities of supervisors to their company, customers, and fellow workers, as well as requirements for successful supervisors, are discussed (*pages 391–3*).

Activities of the Electrical Equipment Subcommittee, Refining Division, of the American Petroleum Institute. One of the problems confronting petroleum refinery engineers is the lack of authoritative rules of good practice. An outline of the scope of the work which this 3-year-old subcommittee has undertaken is presented (*pages 407–09*).

Grain-Oriented Iron-Silicon Alloys. The chemical analysis and certain properties of these alloys are given in connection with a discussion of their development and production. Curves indicate why transformer core designs have been greatly influenced by this development. Production trends are included also (*pages 411–16*).

Type O Carrier System. The demand for large numbers of telephone circuits between near-by towns has made economical short-haul carrier systems essential. The Type *O* carrier systems provide 16 message channels in both directions on one pair of conductors on an open-wire line. It is a companion to the *N* carrier (*Electrical Engineering*, volume 70, number 8, August 1951, pages 692–7) which provides 12 similar message channels on two cable pairs (*pages 418–23*).

Controllability of High-Pressure-High-Temperature Reheat Steam Plants. At an Institute meeting in 1949 the general problem of operating steam power plants was reviewed and it was brought out that to get maximum operating efficiency and minimum maintenance of the steam turbines, the rate of change of load and temperature should be limited under normal conditions. Experience since 1949 and design changes are considered in this article (*pages 426–8*).

The Western Chemical Industry's Growth. This area comprised of 11 states is shown as better situated than the rest of the United States with respect to raw materials, in a good position as far as utility and human resources are concerned, and increasingly stronger in regard to markets with the trend toward greater population and income. Therefore, it is held that the chemical industry should continue to expand at an increasing rate in the West (*pages 434–9*).

Electric Off-On Modulated Servo Clutch Controls. Improvement of nonlinear electromagnetic controls not dependent upon vacuum tube equipment should be considered. These controls have a substantial advantage over other types in weight, simplicity, and acceleration characteristics (*pages 430–4*).

Electrical Properties of the Inorganic Papers. Heat-stable electrical insulating papers, made from both natural and synthetic bases, are now available commercially. Their electrical properties are given to help design engineers evaluate them as insulants in cables, transformers, capacitors, and laminates (*pages 441–3*).

Economical Utilization of Electric Power Equipment. The adoption of the ideas and application of the data and techniques discussed in this article, have permitted one utility company to effect considerable saving in investment (*pages 446–51*).

News Index

Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers (exclusive of ACO's) presented at General and District Meetings. The publications are on an annual subscription basis. In consideration of payment of dues, members may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office 20th & Northampton Streets, Easton, Pa. Editorial and advertising offices 500 Fifth Avenue, New York 36, N. Y. Subscription $12 per year plus extra postage charge to all countries to which the second-class postage rate does not apply; single copy $1.50. Entered as second-class matter at the Post Office, Easton, Pa., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925. May 1953, Vol. 72, No. 5. Number of copies of this issue 55,800.

PHILCO IS THE WORLD'S LEADING MANUFACTURER OF MICROWAVE EQUIPMENT

Philco leads the world in mass production of quality microwave equipment to meet modern industry's demands for relay systems of the highest reliability and performance.

Philco microwave components meet most JAN (Joint Army-Navy) specifications without any changes in circuitry, thereby permitting other users of microwave communications equipment to have the built-in reliability required by the Armed Forces. That is why commercial users of Philco microwave equipment include such famous names as American Telephone & Telegraph Co., Santa Fe Railway System, Bonneville Power Administration, Platte Pipeline Company and many others.

Where quality and reliability are important, look to Philco . . . world's leading manufacturer of microwave equipment!

For complete information write to Department EE

PHILCO Famous for QUALITY the World Over

PHILCO CORPORATION

GOVERNMENT & INDUSTRIAL DIVISION

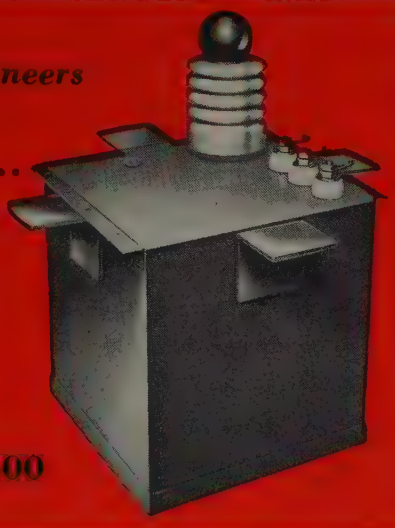
PHILADELPHIA 44, PA.

"We had a high voltage power supply problem . . .

"Our problem was to find a 30,000 volt power supply to be used as a source of voltage for kinescopes. It also had to be suitable for experimental work and in airborne equipment. The main considerations were small size and light weight, but also we needed a design that would conform to military specifications.

"We consulted 'CP' and told them what we needed . . ."

"CPs" engineers came up with this...



Type PS30-3C400

The "CP" Engineering Department designed a power supply with the following characteristics:

Input voltage: 115 V AC

Frequency: 320 to 1000 CPS

Output voltage: 0-30 KV continuously variable — .3 ma rated current.

Ripple voltage: Less than .1 peak-to-peak at maximum rated current of .3 ma

Temperature: To operate over a range of −10°C to +55°C and 95% relative humidity.

General: To operate effectively in any position.

Taking advantage of hermetic sealing and oil-filled construction in addition to new techniques and use of plastic film for high voltage capacitors, Condenser Products' Engineers developed type PS30-3C400 to comply with all requirements. Size of unit is 5½ x 5½ x 6¼". Total weight: 11 lbs.

"CP" is now filling orders for HiVolt Power Supplies

in the following ranges: 2,000 V, 5,000 V, 12,000 V, 15,000 V, 30,000 V, and 50,000 V, at frequencies of 60 cycles and 400 to 1,000 cycles. HiVolt Power Supplies are engineered for various applications. Because of their small size, light weight, flexibility, and ease of operation "CP" HiVolt Power Supplies are ideal for operation of display tubes, radiation counters, photoflash devices, dust and electrostatic precipitators, oscilloscopes, insulation testers, spectographic analyzers and other equipment.

● ***Your engineering problem*** will receive the immediate attention of our design and specification engineers.

Condenser Products Company

Division of New Haven Clock & Watch Company

7517 North Clark Street • Chicago 26, Illinois

Manufacturers of: Glassmike Capacitors • Plasticon Capacitors • HiVolt Power Supplies • Pulse Forming Network

Send for catalogue on:
☐ Glassmikes ☐ HiVolt Power Supplies
☐ Plasticons ☐ Pulse Forming Networks

NAME_____ TITLE_____

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INDUSTRIAL NOTES ....

Westinghouse News. A multimillion dollar plant to produce atomic equipment has been announced by the company. The plant will be operated by a newly formed department in the Atomic Power Division, the Atomic Equipment Division, and will be located in Harmar Township, near Pittsburgh, Pa. At this plant the company will engineer, manufacture, and sell products that have been developed for atomic power plants.

E. T. Morris has been appointed assistant manager of the Atomic Power Division. He was formerly manager of subcontracting in the Defense Products organization.

The Tube Division has announced the following appointments: Verne G. Rydberg, formerly with the sales department, as assistant manager of application engineering for the Electronic Tube Division; Joseph Schlig, formerly manager of advertising and sales promotion, as assistant to the division sales manager; and Emerson Radio Westchester, Inc., White Plains, N. Y., as distributor of Reliatron tubes for the Westchester, N. Y., sales area.

J. P. Coughlin, manager of field sales for the welding department, has been named manager of the arc welding department.

The Headquarters Manufacturing Division has been reorganized. C. G. Wallis, former manager of the headquarters manufacturing department, will serve as assistant to the vice-president in charge of manufacturing. Other appointments include: L. S. Houk, as director of works engineering; N. H. King and R. I. Wilson, director and assistant director, respectively, of production and inventory control; G. C. Moore, director of plant industrial engineering; V. D. Mack, supervisor of manufacturing student training; and Joseph Manuele, director of quality control. A new department, known as the manufacturing and equipment engineering department, has been created. Heading this department will be: Edward Griffiths, director of expense control; W. H. Dickinson, director of manufacturing engineering; and G. P. Longabaugh, equipment engineer.

General Electric Notes. George R. Prout, vice-president of nucleonic and atomic projects of the company, died on March 8, 1953. Mr. Prout was responsible for the company's atomic energy activities, including the Hanford plutonium plant, Richland, Wash., and the Knolls Atomic Power Laboratory, Schenectady, N. Y.

Halbert B. Miller has been appointed manager of manufacturing for the Major Appliance Division, Louisville, Ky.

Carl L. Ipsen, chief consultant for the heating department, has retired to become executive vice-president of the Industrial Furnace Manufacturer's Association, Washington, D. C. Arthur B. Oday, executive division at the Lamp Division's Application Engineering Department, Cleveland, Ohio, also has retired. Mr. Oday had been with the company more than 40 years.

Du Mont Expansion. Allen B. Du Mont Laboratories, Inc., has opened a new plant for the manufacture of cathode-ray instruments for industrial and defense use. The Instrument Division plant is located at 760 Bloomfield Avenue, Clifton, N. J., and adjoins the company's cathode-ray tube manufacturing plant and main offices.

The Television Transmitter Division will now occupy all the space at 1500 Main Avenue, Clifton, which it formerly shared with the Instrument Division.

Freed Name Change. Freed Radio Corporation, New York, N. Y., has changed its corporate name to Freed Electronics and Controls Corporation. Work to be carried out under the new name will include the basic business in radio, radio-phonographs, and television for the home; radar and communications equipment and controls systems for the armed services; optical and electronic radar displays; ultrasonic light and color modulators; and radar indicators and video frequency recorders.

Allen-Bradley Opening Canadian Plant. A new factory building is being erected at Galt, Ontario, Canada, for the manufacture of Allen-Bradley products to serve the Canadian market. Operations will be carried on by Allen-Bradley Canada Limited, a newly incorporated associate of the Allen-Bradley Company, Milwaukee, Wis. The plant will be completed in late summer, 1953.

Ford Instrument Appointment. Charles D. Arcularius has been appointed director of procurement of the Ford Instrument Company, Division of The Sperry Corporation. Mr. Arcularius was formerly subcontract manager.

Rockbestos Sales Appointments. Edward J. Parker has been appointed district sales manager for St. Louis, Mo., and Edward J. Langhenry sales representative in the Chicago, Ill., district sales office of Rockbestos Products Corporation. Mr. Parker was formerly associated with Peter Kiewit Sons Company and John Fabick Tractor Company, and Mr. Langhenry served as a salesman with the Westinghouse Electric Corporation.

Sprague Office Manager. Allan J. Weinberger has joined the Sprague Electric Company as manager of its Dayton, Ohio, application engineering office. Mr. Weinberger was formerly section head of the Test Devices Division of the United States Naval Ordnance Plant, Indianapolis, Ind. He succeeds William M. Lana, who has been transferred to the office at Culver City, Calif., as assistant sales manager.

(*Continued on page 22A*)

RCA transistors —*now available!*

AFTER MORE THAN FOUR YEARS of intensive development work with transistors at the David Sarnoff Research Center—and at the RCA Tube Department—*RCA now makes transistors a commercial reality!*

Backed by RCA's long experience in the field of semi-conductive materials and electron devices, here again is technical evidence of RCA's never-ending effort to provide industry with a quality product consistent with the best engineering practice known today.

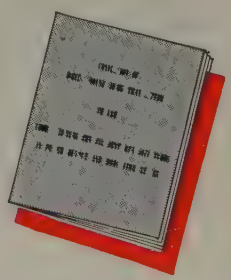
For technical data or design help, write RCA, Commercial Engineering, Section 39ER. Or just call your nearest RCA Field Office:

(EAST) Humboldt 5-3900, 415 S. 5th St., Harrison, N. J.

(MIDWEST) Whitehall 4-2900, 589 E. Illinois St., Chicago, Ill.

(WEST) Madison 9-3671, 420 S. San Pedro St., Los Angeles, Cal.

Write for new technical bulletin on RCA Transistors. The booklet includes characteristics, typical operating conditions, and performance curves. Yours for the asking! Address RCA, Commercial Engineering, Section 39ER, Harrison, N. J.



RADIO CORPORATION of AMERICA

TUBE DEPARTMENT **HARRISON, N. J.**

(*Continued from page 18A*)

Sanson Appointed Cope Sales Manager. T. J. Cope, Inc., Philadelphia, Pa., has announced the appointment of A. M. Sanson, Jr., as sales manager. He will supervise the sales of the company's line of cable installation equipment and will be in charge also of the sales of cable trough systems.

RCA Appointments. Edward C. Hughes, Jr., has been appointed assistant to the executive vice-president of the Radio Corporation of America. Mr. Hughes has been with RCA since 1930.

Two officials of RCA Victor Division have been selected to take the advanced management course at the Harvard School of Business Administration. The officials are Warren E. Albright, general plant manager of the Home Instrument Department, and Richard C. Willman, chief design engineer, custom products engineering.

Sylvania Los Angeles Sales Manager. The Lighting Division of Sylvania Electric Products Inc. has announced the appointment of R. C. Harper as sales manager of the Los Angeles, Calif., district and William L. Friend as manager of the San Francisco, Calif., office.

Division Established by Detroit Edison. A newly established division of Detroit (Mich.) Edison's Sales Department, to be known as the Area Development Division, will be directed by Vincent S. Madison, former power sales engineer. The Division will be responsible for a continuing program to attract new industry to southeastern Michigan and to retain and encourage the expansion of existing industry.

NEW PRODUCTS . . .

Flow-Measuring System. The Gavco Corporation, New York, N. Y., has presented a major contribution to the aviation industry called the Flow Meter. This electronic device computes accurately the fuel consumption in weight units that will compensate for the changes in density and temperature of liquids. The invention is thus of tremendous significance to jet aircraft whose fuels can be of various densities and which in addition fly quickly to freezing altitudes. The new Gavco unit measures the flow in gallons but then automatically compensates for the weight of the fluid, producing a continuous pounds-per-hour dial reading. It provides continuous compensation for density; the measurement of density of liquid is continuous, is not performed in successive batch sampling. The density detector measures variations in density to 1 per cent.

(*Continued on page 28A*)

(*Continued from page 22A*)

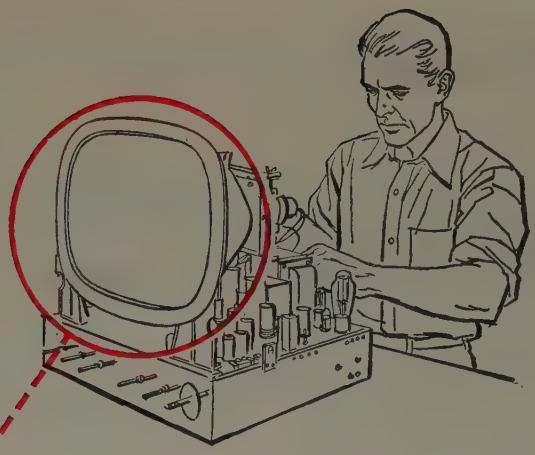
The volume-sensing element measures rate of flow to 1/2 per cent through the full flow ratio of 1/60; pressure drop through the element is negligible, less than 1 pound per square inch at 20,000 pounds per hour. Weighing only 8 pounds complete, the system has four parts: a sensing unit which is placed in the fuel line; a density detector also connected to the fuel line; an electronic integrator which computes information received from the foregoing units; and a dial indicator for the instrument panel.

High-Voltage Relay. A new high-voltage high-vacuum relay (*PS-32*) with an externally operated d-c solenoid has been developed by Pioneer Electronics Corporation, Santa Monica, Calif. The relay, an advance in high-voltage miniaturization, is $4^1/_4$ inches high with a 300-ampere peak-pulse current rating, a pulse duration of 3 microseconds and a vibration characteristic of 15 g's acceleration. The unit has been designed primarily for partial oil immersion applications for switching pulse-forming networks in radar installations. The lower portion of the switch can be hermetically sealed directly into the pulse-forming network case, transformer, or other oil-filled device. The unit may be specified for use in environments that are corrosive, where explosive atmospheres are encountered, and for high-altitude application. Complete data available from manufacturer on request.

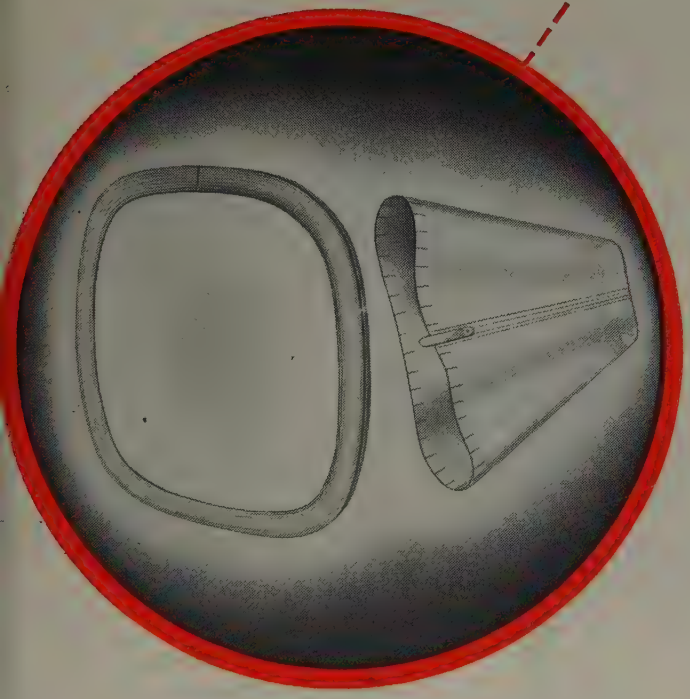
Lighting Transformers. Marcus Transformer Company, Hillside, N. J., announces a new line of general-purpose lighting transformers designed specifically for quicker, easier installation outdoors as well as indoors. Designated as Marcus "Type C," the new transformers are available in sizes from 1 to 15 kva, single phase and 3 phase, up to 600 volts. The new models feature Class *B* heatproof, high-dielectric high-heat insulation with the new Du Pont "Mylar" polyester film which has at least ten times the puncture strength of standard magnet wire. To permit mounting outdoors, the housing of the new transformer has been redesigned with an electrically welded sheet steel case, and vents scientifically placed to provide weatherproof ventilation.

Speedomax Console Indicator. A new electronic console indicator saves panel space and permits an operator to scan up to 200 thermocouple temperatures as fast as he can log them. This console unit consists of an executive-type desk with a mounting which houses a specially adapted Speedomax Indicator and flanking switch panels. The mounting extends only 13 inches above the desk to give the operator an unobstructed view of the main control room panel. Because the special housing slopes at 60 degrees, a seated operator can read the $25^1/_2$-inch drum-type scale with ease as it spins from point to point and stops "dead still." Balancing time is only 4 seconds full-scale, 2.5 seconds half-scale. The scale is calibrated for single or double ranges. For further information, write

(*Continued on page 34A*)



Du Pont "Alathon"* insulates TV tube carrying 20,000 volts



Rings and sleeves extruded by
Anchor Plastics Co., Inc.
New York, N. Y.

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DU PONT
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Better Things for Better Living
. . . through Chemistry

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DEPARTMENT
PLASTICS • CHEMICALS

Ring and sleeve of "Alathon" retain dielectric properties . . . pass humidity tests . . . lower shipping costs

When television-set manufacturers started using metal picture tubes, they were faced with the problem of insulating the outer portion of the tubes that carry up to 20,000 volts. A material was needed that could withstand the voltage, while resisting humidity that would ruin its insulating value.

The solution was this ring and sleeve extruded of Du Pont "Alathon" polythene resin. Of all the materials tested, only "Alathon" retains its electrical properties in service. "Alathon" has excellent dielectric strength, low dielectric constant (2.3), and low power factor (0.0005). Because of its very low moisture-absorption rate (0.01% by A.S.T.M. test), "Alathon" easily passed exacting humidity tests.

Du Pont "Alathon" offers other important advantages. Its flexibility simplifies installation. Shipping costs are reduced because "Alathon" absorbs shock . . . makes possible packing of sets as units . . . eliminates shipping the delicate tubes separately. And reassembly time and labor at outlets are eliminated. Many TV manufacturers now use these rings and sleeves.

Du Pont "Alathon" is widely used for such insulating applications as TV lead-in wire, high-voltage TV lead wire, and police and fire-alarm cable. We will gladly suggest suppliers who can meet your specific needs for electrical or other uses of "Alathon." For further information, write:

E. I. du Pont de Nemours & Co. (Inc.)
Polychemicals Department,
Room 215 A, Du Pont Building
Wilmington 98, Delaware

(*Continued from page 28A*)

Leeds and Northrup Company, 493 Stenton Avenue, Philadelphia 44, Pa.

Miniature Medium-Mu Triode. A new miniature 7-pin medium-mu triode, designated the *6T4*, has been released recently by the Radio Tube Division of Sylvania Electric Products Inc. The tube was designed as an oscillator in television tuners or converters covering the new ultrahigh-frequency bands. The tube features short bulb, t-5½ construction having a maximum over-all length of 1¾ inches, and a maximum seated height of 1½ inches. The Sylvania *6T4* also features double-plate and grid connection to reduce lead inductance. In circuit designed for its use it is capable of operation up to 1,000 megacycles.

Flexible Heating Tape. Ribbon Heat Aeronautical, a flexible, flame-resistant heating unit, is the first heating tape on the market with a unique "wrap-around" feature for application on pipes, tubing and fittings. Combining safety, durability and low temperature, Ribbon Heat Aeronautical comes in tapelike form about ½ inch wide and 0.1 inch thick, making it ideal for maintaining desired temperatures of liquids in hydraulic and rocket fuel systems. Cox and Company, manufacturers of this new product, has appointed Air Associates, Inc., Teterboro N. J., as a distributor.

Frequency-Correcting Device. An instrument for detecting and recording frequency errors in the a-c output of power plants is being produced by the Industrial Division of Minneapolis-Honeywell Regulator Company. The device, an electronic time deviation detector-recorder, indicates needed adjustment of frequency output and thus assures the correct operation of electric clocks and other timing devices on the line. It is designed so that if maintenance is needed on the recorder the detector continues to operate independently. When the recorder is again attached, it will indicate, correct to within 10 seconds, any error which occurred while it was shut down.

Quiet Mechanical Light Switch. The Arrow-Hart and Hegeman Electric Company of Hartford, Conn., announces what is said to be the first truly quiet mechanical light switch. Known as the "Lifetime Quiette Switch," it can be installed in any position, not just up and down, as is said to be the case with other quiet switches now on the market. It can be used with both incandescent and fluorescent lights.

Fault-Location Wheatstone Bridge. A compact Wheatstone Bridge for general laboratory use or field servicing of communications systems is available from the Shallcross Manufacturing Company, Collingdale, Pa. The Model *6100* Wheatstone Bridge measures resistance between 1 and 1,011,000 ohms to an accuracy of +0.1 per cent +0.01 ohm. The instrument

(*Continued on page 40A*)

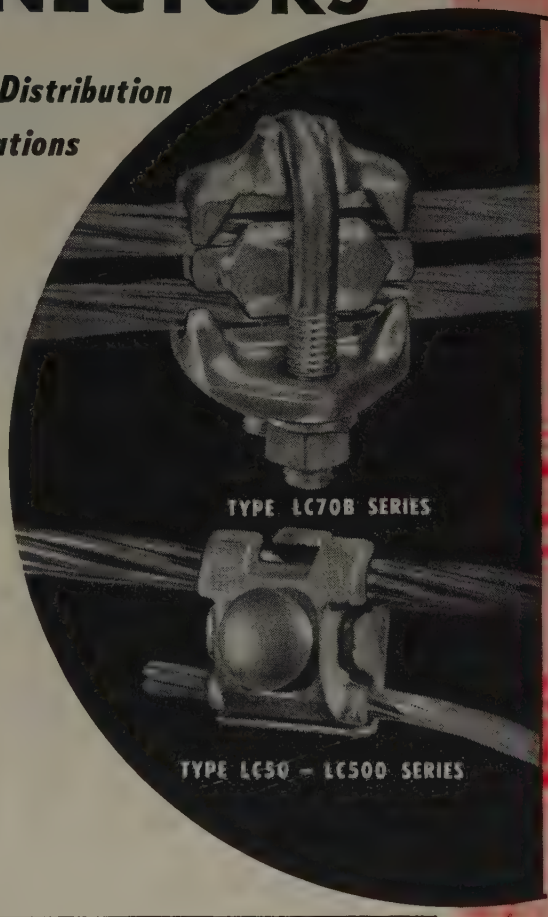
New

ANDERSON

TYPE LC50 — LC500 — LC70B SERIES

ALUMINUM CONNECTORS

For Wider Aluminum Distribution System Applications



Inventory Reduced — Increased range, fewer connectors to stock, less cost.

Dependability Assured — For more than a quarter century a leader in engineering and manufacturing aluminum connectors.

Controlled Quality — From ingot to finished product.

CATALOG NUMBER	MAIN	TAP
LC-51A	#6—1/0 ACSR	#6—#2 ACSR
LC-52A	#6—1/0 ACSR	#6—1/0 ACSR
LC-511A	#6—1/0 ACSR	#8—#2 COPPER CABLE
LC-522A	#6—1/0 ACSR	#8—1/0 COPPER CABLE
LC-70B	#6—#2 ACSR	#6—#2 ACSR
LC-71B	#6—1/0 ACSR	#6—1/0 ACSR

Consult one of our nearest 18 representatives or contact our main office.

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POWER CONNECTORS
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ABW

ANDERSON BRASS WORKS INCORPORATED

BIRMINGHAM 1, POST OFFICE DRAWER 2151 ALABAMA

(*Continued from page 34A*)

built to the standards of precision required for laboratory measurements, yet with the ruggedness, ease of operation, and compactness essential for field service. Housed in an aluminum case, the bridge weighs 8 pounds and measures $8^7/_8$ inches long by $5^3/_4$ inches high. Instructions for all measuring operations are mounted in the lid.

Sensitive Inverter. The Ballantine Sensitive Inverter Model *700* in combination with a suitable 60-cycle-per-second voltage-sensitive device makes possible the accurate measurement of d-c potentials as low as 10 microvolts, and the detection of d-c potentials as low as 1 microvolt while presenting to the source a resistance not less than 10 megohms. It may be combined with a vacuum-tube voltmeter, voltage amplifier, oscilloscope, multimeter, servo-amplifier, or any other device sensitive to 60-cycle-per-second voltages in the range 100 microvolts to 10 volts. As a sensitive transducer the model *700* inverts d-c potentials to alternating voltages directly proportional in magnitude to the d-c input voltages and phase sensitive to the d-c polarity. The inversion ratios (d-c to a-c rms) are 1:1000 and 10:1. An important feature is a built-in calibrator which minimizes the errors caused by a companion instrument or by the departure of line frequency and voltage from nominal values.

Miniature Selenium Rectifier. A new line of miniature selenium rectifiers, ranging from 3/32 to 15/32 inch in diameter, has been announced by the General Electric Company's Lighting and Rectifier Department. Designed as nonexpendable components for industrial and government equipment, the miniature stacks operate small relays, solenoids, and precipitators. Circuit applications include: electronic, blocking, computer, signal, magnetic amplifier, communication, and control. The assemblies, according to General Electric engineers, have a ambient temperature range of minus 55 degrees centigrade to plus 100 degrees centigrade. At an ambient temperature of 35 degrees centigrade, the single-stack rating ranges from 0.5 milliampere d-c at 25 volts rms to 25 milliamperes d-c at 5,200 volts rms. Higher ratings result from combining the stacks.

General Electric Tubes. The *GL-6182* is a 4-electrode transmitting tube featuring a metal-and-ceramic envelope designed for use as a power amplifier or oscillators in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating 7 kw. Cooling is accomplished by water and forced air with the water jacket an integral part of the anode. The cathode is indirectly heated and thoria coated. Maximum ratings apply up to 900 megacycles.

The *GL-6283* 4-electrode transmitting tube with a metal-and-ceramic envelope

(*Continued on page 52A*)

ILASTIC helps Westinghouse score another FIRST...*
COOKING without LOOKING"

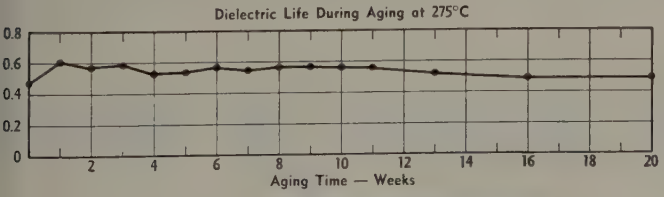
Engineers have been working for years to make a heat control system for electric range surface units that would forever banish pot watching. But it took Westinghouse, using a bit of Silastic, a thermistor, and a few relays and vacuum tubes, to perfect the "Electronic Eye." This heat control system regulates the temperature so accurately that food can be warmed, boiled or fried without danger of burning or scorching—even if all the water is boiled away. The heart of the temperature measuring device, the thermistor, is embedded in Silastic paste for protection and heat transfer. Flexible Silastic insulated cable is used to connect the thermistor to the exterior wiring, and the Electronic Eye itself is isolated in the center of a flexible Silastic diaphragm. The Silastic components have stood up under exposure to boiling water, oil, grease, coffee and syrup, as well as accelerated life testing equivalent to 15 years of actual service.

Performance proves...

SILASTIC works

where other materials fail!

any of the most able designers, like those Westinghouse en who made automatic cooking a practical reality, save ne and money by trying Silastic first when they need bbery properties at temperatures far above or below the nits of any ordinary rubber. And exceptional stability at oth high and low temperatures is combined in Silastic with xcellent resistance to outdoor weathering and good resist- nce to a variety of hot oils and chemicals. Further proof of e inherent stability of Silastic is given in this small graph showing the effect of aging at 275°C (527°F) on the dielectric strength of Silastic.



Dielectric strength measured with ¼ inch electrodes in air on two layers of Silastic R Tape, for example, average 0.475 KV per mil. After 20 weeks of continuous aging at 275°C with both surfaces exposed in an air circulating oven, dielectric strength gradually decreased from a high of 0.601 to 0.485 KV per mil.

That's the kind of performance that makes Silastic, the Dow Corning silicone rubber, unique among all rubbery materials. When you need rubbery properties at temperatures above 150°F or below —40°F, or excellent dielectric properties in a resilient and flexible material ***specify Silastic.***

MAIL COUPON TODAY FOR DATA ON THE PROPERTIES, PERFORMANCE AND APPLICATIONS OF SILASTIC.

DOW CORNING CORPORATION, Dept. H-5, Midland, Michigan

Please send me:

- ☐ Silastic Facts 10a, properties and applications of Silastic stocks and pastes.
- ☐ List of Silastic Fabricators.
- ☐ "What's A Silicone?", your new 32-page booklet on silicone products and applications.

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Company _____

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City _____ Zone _____ State _____

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DOW CORNING CORPORATION
Midland, Michigan

nada: Fiberglas Canada Ltd., Toronto • England: Midland Silicones Ltd., London

(*Continued from page 40A*)

is a power amplifier or oscillator designed particularly for use in grounded-grid circuits where both grids are maintained at radio-frequency ground potential. Under such conditions in a tetrode the output circuit is connected between the anode and the screen grid. The tube has an indirectly heated oxide-coated cathode, a plate dissipation rating of 200 watts, and is forced-air cooled. Maximum ratings apply at frequencies up to 900 megacycles.

TRADE LITERATURE

Insulation Catalogue. Cotton, glass, and asbestos woven tape, braided sleevings, and cords for electrical insulating purposes are described in a new free 28-page catalogue. Information on applications, properties, technical data, sizes, types, and packaging is included. These products are used in motors coils, television sets, transformers and other electrical units in a variety of ways. As well as covering the Imcor, Electra, Fiberglas, R/M, and Asbeston brands of cords, tapes, and sleevings, the catalogue explains characteristics of the basic cotton, glass, and asbestos fibers. Copies of this catalogue may be obtained without charge from the Publications Department, Insulation Manufacturers Corporation, 565 West Washington Boulevard, Chicago 6, Ill.

Composite Metals. The General Plate Division of Metals and Controls Corporation, Attleboro, Mass., has issued an illustrated 12-page catalogue which describes the various composite metals, precious metals, electric contacts, and Truflex metals manufactured by the company and explains the various products which it fabricates. Its contents cover some of the unusual composite metals which General Plate has developed recently, including information of the platinum-group metals and manganese age-hardening alloys. Of interest are the sections which cover thin gauge rolling and mirror finish rolling. Copies of the catalogue are available by writing direct to the company.

Electric Motors and Controls. Specifications and illustrations of all Gleason-Avery synchronous and nonsynchronous instrument motors, series "*500*" gear reduction motors, and temperature controls, complete with rating charts and mounting dimensions, are available. The new catalogue may be had by writing Gleason-Avery, Inc., 45 Aurelius Avenue, Auburn, N. Y.

Radiant Panel. Specifications of the new Chromalox electric far-infrared radiant panel are detailed in a 4-page folder for use by Federal, State, and local govern-

(*Continued on page 54A*)

(*Continued from page 52A*)

ment purchasing agencies, and others re quired to purchase by invitation and bid Twenty-four separate items are covere to include every component part an characteristic of the panel in nonrestrictiv language. The modular panels are as sembled into complete infrared ovens, an include full insulation and electric bus To obtain a copy, write to Edwin L Wiegand Company, 7599 Thomas Boule vard, Pittsburgh 8, Pa., requesting *L-1093*

Instrument Data Sheet. A quick ref erence data sheet covering a complete lin of electric measuring instruments is avail able. This sheet lists models for insulatio resistance, ground resistance, and high voltage testing plus other special-purpos instruments. For free copies write Rober G. Davis, Associated Research, Inc., 375 West Belmont Avenue, Chicago 18, Ill. requesting Bulletin *10AA.*

Electric Equipment in Automotive In dustry. Modern electric equipmen and the role it plays in the mass pro duction automotive industry are describe in a 36-page booklet from Westinghous Electric Corporation. The characteristic of motors, controls, packaged drives dynanometers, and many other types o electric apparatus that insure a continue high production rate are discussed. Desig and test procedures that have made i possible to surpass JIC standards fo electric apparatus are also described Each type of equipment is appraised i relation to its place in the productio line. For a copy of booklet *B-5651*, writ Westinghouse Electric Corporation, Bo 2099, Pittsburgh 30, Pa.

Electrical Tapes and Related Products A 12-page illustrated booklet describin "Scotch" brand electrical tapes an related electrical products for constructio and maintenance has been announced b Minnesota Mining and Manufacturin Company, 900 Fauquier Street, St. Paul Minn. The booklet discusses use o "Scotch" plastic electrical tapes numbe 21, 22, and 33 in industrial and hous wiring, appliance repair, undergroun cable splicing, and other heavy-dut applications. In addition, it tells ho "Scotch" glass cloth electrical tape numbe 27 with a thermosetting adhesive is use for sealing, holding, and insulating whe high temperatures are involved. Als described are such new accessory produc as "Scotchlok" electric spring connecto for splicing, electrical insulation putty and electrical coating for use as an oute seal on plastic tapes subjected to abnorma quantities of oil or contaminated wate The booklet is available upon request fro the manufacturer.

Motor Controls. The Allen-Bradley Com pany of Milwaukee, Wis., has released

(*Continued on page 58A*)

This booklet marks our
forthcoming 50th Anniversary.
It answers the question . . .
"WHAT CAN WE DO FOR YOU?"
Send for your copy today.

ROLLER-SMITH CORPORATION
AND ELPECO DIVISION
BETHLEHEM • PENNSYLVANIA

CIRCUIT BREAKERS • INSTRUMENTS • SWITCHGEAR • PRECISION BALANCES
WATTHOUR METERS • POWER SWITCHING EQUIPMENT • SUBSTATIONS • BUS DUCTS

(*Continued from page 54A*)

new 28-page bulletin, "Quality Line Motor Controls for All Industries." this bulletin the most important items Allen-Bradley's line of standard moto control apparatus have been outline A special feature of the bulletin is th section illustrating glimpses behind th scenes of the Allen-Bradley Compan Requests submitted on company lette head, will receive prompt attention.

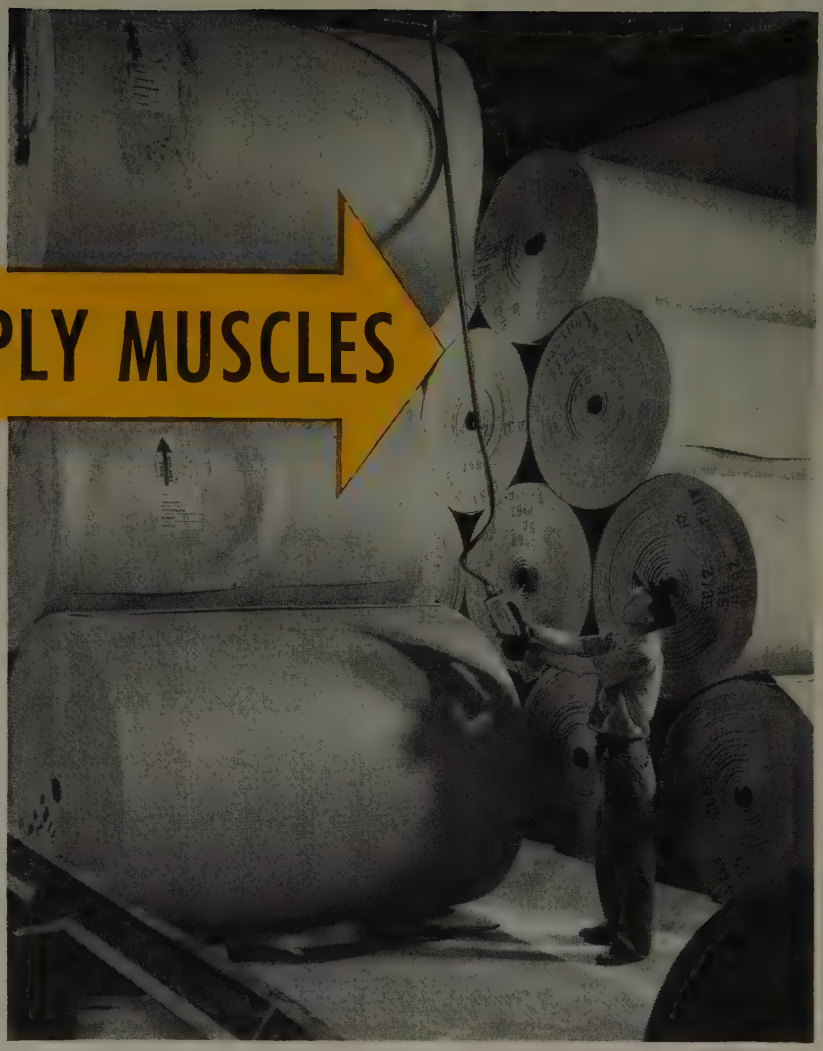
Fuse Catalogue. General Electric's Co struction Materials Division has issued complete fuse catalogue which cove renewable time-delay fuses, 1-time fuse plug fuses, fuse holders, and copper lin fuses. A technical data section is al incorporated in the catalogue and cove such subjects as how a fuse operate maintenance hints, excerpts from th 1951 National Electrical Code pertainin to fuses, and dimensions of fuses and fu holders. This illustrated catalogue available from the General Electric Com pany, Bridgeport 2, Conn.

Transformer Laminations. Allegheny Ludlum is presenting a greatly expande description of laminations in the fift edition of its transformer laminatio catalogue. Included is technical inform tion and full-size drawings of all th available standard shapes. These lamin tions are obtainable in a large number magnetic materials and a variety thicknesses. Each lamination is provide with a weight table to assist in orderin The company's magnetic-shield fabrica ing facilities are also described. Fr copies of the catalogue are available companies in the field upon request to th Advertising Department, Allegheny Lu lum Steel Corporation, 2020 Oliv Building, Pittsburgh 22, Pa.

Plant Electric-Power Distribution Pra tices. A bulletin, a guide for pla engineers on electric-power distributio practices in large and small plants, h been announced by the General Electr Company, Schenectady, N. Y. The 2 page, illustrated bulletin, designated *GE 5900*, is entitled "Industrial Power D tribution Idea Book." The publicatio covers utility distribution practices; met ods of buying electric power; what to when a choice of primary voltages available; application of primary switch and circuit breakers; types and arrang ments of primary cables; and types load-center distribution systems. Also d cussed are use of branch feeder switche starters, and fuses; grounding of system combined power and lighting; how calculate interrupting capacity; how apply capacitors; methods of obtainin economical direct current, and oth allied subjects.

Current-Carrying Capacity Tables. booklet, entitled "Okolite-Okoprene Cabl for Direct Burial Installations," should

(*Continued on page 60A*)



HOW TO MULTIPLY MUSCLES

These huge rolls of paper are lifted off delivery trucks and put into the stock piles as easily as though they were spools of thread. It's only another example of how we multiply muscle power with electric muscles. Here an overhead crane operated and controlled by push buttons in the hands of this workman responds like a genie to every direction.

This is only another of the many jobs that TIREX Portable Cords do so well. This pendant control station may be banged around; it is subject to abrasion and to strains of one kind and another. Even oil dripping from the crane may get on this cord. Yet day after day, week after week, even year after year, TIREX Cords give dependable, satisfactory service. Isn't that what you want when you buy a cord? We think so too.

Why don't you buy some TIREX for that difficult job you have and prove to yourself that TIREX lasts and lasts. Get it from your local distributor. He has most sizes in stock. Be sure, though, that you get genuine Simplex-TIREX with the special neoprene armor that is cured in lead.

Simplex

WIRES & CABLES

SIMPLEX WIRE & CABLE CO.

79 Sidney Street, Cambridge 39, Mass.

(*Continued from page 58A*)

of interest to users of 0- to 5,000-volt non metallic sheathed power cables. Brief and factual, the booklet contains construction features, dimensional data, installation recommendations, and current-carrying capacity data not generally available. For copies write for bulletin *OK-1066*, The Okonite Company, Passaic, N. J.

Bourdon-Tube Materials. "Selecting and Working Bourbon-Tube Materials," has been reprinted and made available by Superior Tube Company, 1509 Germantown Avenue, Norristown, Pa. Bourdon tube is the actuating element for the majority of pressure and temperature indicating and recording instruments. The article gives characteristics of three groups of alloys commonly used for Bourdon tubes: strain-hardened alloys, precipitation-hardened alloys, and quenched and tempered alloys. Two methods of coiling Bourdon tubes are described: mandrel coiling and coiling with filler, and three common methods of joining, welding, brazing, and soft soldering, are discussed. Photographs illustrate three types of coiling: circular segment, spiral coil, and helical coil, as well as various oval and elliptical cross sections.

—

Chart of the Nuclides. Nearly 1,300 different kinds of atoms now known to exist are shown in the fourth edition of the "Chart of the Nuclides," distributed by the General Electric Company and prepared by the Knolls Atomic Power Laboratory. The chart is arranged in checkerboard form, with a square for each nuclide or kind of atom. Three kinds of atoms are indicated by the shading of the squares. In the various squares are given the mass, abundance, and other technical data concerning the nuclide. For those that are radioactive, the half-life also is given. Copies of the chart, and an 8-page booklet describing it, may be obtained without charge, on request to the General Electric Company, Department 2-119, Schenectady, N. Y.

Quinterra—Quinorgo. "Quinterra—Quinorgo" is the title of a 32-page publication issued by Johns-Manville. It gives complete information about these electrical insulations made of purified asbestos, why they were developed, what their characteristics are, where they may be used to advantage. Tables give test data on physical and electrical properties and test methods are explained fully. Advice on application techniques and equipment includes step-by-step photographic coverage of methods in use now. Copies of the publication are available from Johns-Manville, 22 East 40th Street, New York 16, N. Y.

Mercury-Vapor Lamps. A 25-page revised and updated version of the mercury-vapor lamps booklet is available from the Westinghouse Electric Corporation. The new booklet includes information on both the fluorescent-mercury- and straight-

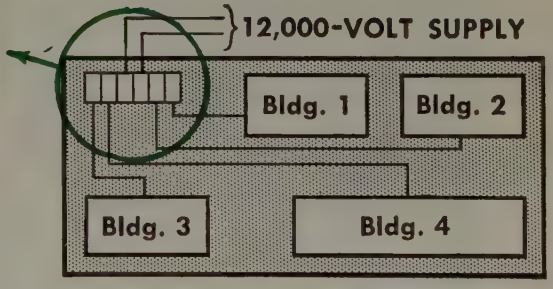
(*Continued on page 62A*)

METALCLAD SWITCHGEAR PROVIDES

Low Cost Switching Centers

S&C has demonstrated time after time that expensive circuit breakers are usually unnecessary in switching centers. S&C Switchgear serves every needed purpose in high voltage industrial power distribution, at a cost usually about half that of circuit breakers.

In an aircraft plant, for instance, selection of S&C Metalclad Switchgear substantially reduced cost of the switching center. This 6-bay unit provides two separate metered sources of power, and protection for the outgoing feeders to the load centers in each of the buildings.



S&C BRINGS A NEW CONCEPT OF PROTECTION AND SERVICE

C equipment has been recognized by public utility gineers as "tops" for over 40 years. WHY? Because permits greater flexibility in substation layouts—eater dependability in performance—greater con-nience and safety of operation.

A new booklet on Metalclad Switchgear explains the fundamental concepts of S&C engineering, and how they affect the economics of industrial power distribution. Would you like a copy? Send the coupon.

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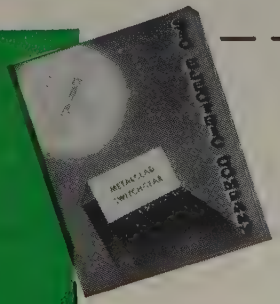
CIALISTS IN HIGH - VOLTAGE CIRCUIT INTERRUPTION



S&C Electric Company
4427 Ravenswood Ave., Chicago 40, Illinois

Please send me your new booklet on S&C Metalclad Switchgear. No obligation on my part, of course.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

(*Continued from page 60A*)

mercury-type lamps. Besides giving general mercury-lamp application information and performance data for all types and sizes, the booklet includes primary discussions about lamp and lumen maintenance, lamp temperature, and ambient temperature. A compact table gives standard information on all sizes and types of mercury lamps available. Special and ideal applications of all types and sizes of mercury-vapor lamps are pointed out in a special application section. The booklet also contains sections on history, lamp construction, and mercury radiation characteristics. A section on auxiliary equipment discusses typical mercury-lamp circuitry and performance of the lamp when used with various transformers. For a copy of this booklet, *A-5112*, write Westinghouse Lamp Division, MacArthur Avenue, Bloomfield, N. J.

Vidicon Components. A 16-page booklet, issued by the RCA Tube Department, supplies technical information on deflection-circuit components for the *RCA-6198* Vidicon, the small camera tube for industrial television applications. Used in the recommended circuits shown in the booklet, these components feature characteristics which provide good sweep linearity, high deflection sensitivity, efficient coupling between circuits, proper focusing, and accurate alignment of the electron beam. These new components permit the design of either a combined camera unit and control unit, or a camera unit separated from its control unit. These components include deflecting yoke, focusing coil, alignment coil, horizontal-deflection-output transformer, and vertical-deflection-output transformer. A copy of RCA Vidicon Components (form *CTV-1016*) may be obtained on request from Commercial Engineering, RCA Tube Department, Harrison, N. J.

Wiring Diagram Bulletin. A 24-page wiring diagram bulletin, describing the ways the Allen-Bradley Bulletin *709* magnetic across-the-line starter can be applied, is being offered by the Allen-Bradley Company, Milwaukee, Wis. Here are illustrated both wiring diagram symbols and line diagram symbols, and wiring systems for various across-the-line starter applications. Each wiring system is shown in two ways: there is a wiring diagram and below it is a line diagram. The wiring diagrams include all the devices in the system and show their physical relation to each other. All poles, terminals, coils, and so on, are shown in their proper place on each device. These diagrams are helpful in wiring up systems because connections can be made exactly as shown on the diagrams. The line diagram is a representation of the system showing everything in the simplest way. Wiring diagrams are shown for all sizes of starters; 1-, 2-, and 3-phase systems; jogging; 2-wire control; pump operation; thermostat control; sequence control; and many others. Copies are available on request to the Allen-Bradley Company, Milwaukee, Wis.

HIGHLIGHTS .....

AIEE Fellows. Recent changes in the AIEE Constitution have made the Fellow grade available by invitation only to those who have attained distinction as a result of the importance, originality, or responsibility of their work. In honor of those members who have been elevated to this grade, a new department, "AIEE Fellows Elected," has been added to the magazine. This department will contain biographical sketches, summaries of outstanding achievements, and photographs of all new AIEE Fellows (*pages 560–3*).

Summer General Meeting. This month's cover, featuring Old Absecon Light on the northeastern end of Absecon Island, now Atlantic City, N. J., heralds the 1953 Summer General Meeting of the Institute to be held at the famed seaside resort city. Not only will the meeting present the usual comprehensive program of technical sessions, but the varied recreational facilities offered by the meeting site should make this a perfect opportunity for a week of relaxation (*pages 544–9*).

President's Address. President Quarles reports on several matters of current interest to the membership in his address at the recent Southern District Meeting of the Institute in Louisville, Ky. (*pages 477–9*).

Plastic Electrets and Their Applications. The nature and behavior of plastic electrets are presented and compared to available information on wax electrets. Engineering applications are discussed and experimental results evaluated in the light of present-day theories concerning electret phenomena (*pages 511–14*).

Management and the Engineer. "Every management plan must have as one component a concrete program for the development of people." In this article, the author considers that portion of a management plan which is concerned with the development of the engineer (*pages 491–5*).

Safety Regulations. Effects of safety regulations are felt by all segments of the electrical industry. Their applications to the field of supply and utilization of electric energy and the necessity for reasonable safety standards to minimize potential hazards to the public are discussed (*pages 480–2*).

Trends in Detection and Measurement of Radioisotopes for Medical Purposes. A review of the latest developments of radioisotopes used in medical therapy, diagnosis, and research, and the instruments which are being used for their detection and measurement is presented. Only the detection of beta and gamma radiations are considered as they are being used currently (*pages 484–9*).

Insulation Co-ordination. The opinions and methods of approach of one group of individuals working on the problem are presented in the hope that this analysis will aid in understanding the problem and promote national and international standardization of insulation levels. Although basic impulse insulation levels above 1,050 kv are not considered since preferred system voltages have not been designated, it is suggested that the same philosophy of protection be applied in establishing the higher levels (*pages 497–503*).

Nuclear Power Plant Controls. Plant operational and control requirements are discussed together with plant dynamics, other miscellaneous plant information, and component characteristics and limitations. It is concluded that a given performance can be specified for a nuclear power plant, and then the reactor and its associated equipments can be made to supply the required output (*pages 505–09*).

The XY Toll Ticketing System. The designer of an automatic toll ticketing system is confronted with the need for an inexhaustible medium on which to store temporarily the billing information until the data are printed as a toll ticket. A magnetic tape has been used successfully in the system described (*pages 517–22*).

The Reliability Required in the Petroleum Electric System. A discussion of the degree of reliability necessary for various types of refinery units is followed by the suggestion that the automatic secondary selective system be utilized to supply the most critical loads (*pages 522–4*).

News Index

Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers (exclusive of ACO's) presented at General and District Meetings. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. The publications also are available to Student members at the annual subscription rate of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Principles of Load Allocation Among Generating Units. An over-all picture of present-day practice and problems reviews the present status of load division between plants and units on a power system, taking into account the last 5 years of progress in telemetering, transmission-loss determination, generator temperature capabilities, boiler temperature limitations, automatic boiler control, and automatic combustion control. Capability and reserve also are discussed briefly (*pages 526–9*).

Air-Turbine Accessory Drives. The reasons for the selection of an air-turbine drive, the problems encountered in the selection, and the methods of overcoming them are discussed. The air turbine is shown to be useful in achieving reduction of aircraft weight and complexity (*pages 530–3*).

Nickel-Base Indirectly Heated Oxide Cathodes. The authors review the possible mechanisms of emission, consider the performance characteristics of oxide cathodes, and comment on the properties of various cathode nickel alloys and their effect upon cathode performance (*pages 536–40*).

ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office 20th & Northampton Streets, Easton, Pa. Editorial and advertising offices 500 Fifth Avenue, New York 36, N. Y. Subscription $12 per year plus extra postage charge to all countries to which the second-class postage rate does not apply; single copy 1.50 Entered as second-class matter at the Post Office, Easton, Pa., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925. June 1953, Vol. 72, No. 6. Number of copies of this issue 54,600

PERMANENT MAGNETS and ASSEMBLIES for Magnetrons and Traveling Wave Tubes

The group of magnets illustrated above, weighing from a fraction of a pound up to 75 pounds, are indicative of the wide range of Arnold production in this field. We can supply these permanent magnets in any size or shape you may need, with die-cast or sand-cast aluminum jackets, Celastic covers, etc. Complete assemblies may be supplied with Permendur, steel or aluminum bases, inserts and keepers as specified . . . magnetized and stabilized as desired. ● *Let Arnold handle your magnetron and traveling wave tube permanent magnet requirements.*

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. . . ANY SIZE, SHAPE OR COATING REQUIRED

★ *We'll welcome your inquiries*

YOU HAVE TO GO INSIDE

Almost all cables look alike on the outside. You have to go inside the jacket to the insulation if you want to see how good the cable really is. In power cables it's the insulation that makes the difference. This fact may be borne out in years of service or as a result of rigorous laboratory tests.

ANHYDREX SA insulation is guaranteed not to absorb more than 20 milligrams of water when soaked at 158°F. (70°C.). Its dielectric constant will not exceed 3.2 after one day's immersion in water at 158°F. (70°C.). Between one day and eight days' immersion in water at 158°F. (70°C.), the increase of capacitance will not exceed 3.5% for insulation thicknesses greater than 4/64″ or 5% for insulation thicknesses of 4/64″ or less. At the end of eight days in water at 158°F. (70°C.) the power factor will not exceed 1%.

No ANHYDREX cable has ever failed due to water absorption. There is no better proof that the electrical properties of ANHYDREX SA insulation remain remarkably stable in the presence of water for a long period of time. Specify ANHYDREX SA insulated cables for underground, duct, or aerial installations at voltages up to 2000 V.W.P. For more complete information, contact your nearest Simplex representative or write to the address below.

SIMPLEX ANHYDREX

SIMPLEX WIRE & CABLE CO., 79 SIDNEY ST., CAMBRIDGE 39, MASS.

INDUSTRIAL NOTES ....

General Electric Notes. A new "soundproof" building for noise-testing transformers at a lower cost was announced by the Power Transformer Department in Schenectady, N. Y. Test results are expected to point the way to reducing vibrations in even the largest units. The sound test building, which will be ready for use early in 1954, was designed by Charles T. Main, Inc., Boston, Mass., and is being constructed by the Gilbane Building Company, Providence, R. I.

The Wiring Device Department at Bridgeport, Conn., and the Monowatt Department at Providence have been consolidated into a new department to be known as the G-E Wiring Device Department with headquarters at Providence. Abe F. Warren has been appointed general manager and Arville W. Gilmore assistant general manager. Both General Electric and Monowatt brand lines will be retained and manufacturing operations will be continued at present locations.

Dr. Walter R. Hibbard, Jr., has been appointed manager of the newly established alloy studies section in the Research Laboratory's Metallurgy Research Department in Schenectady.

Gordon R. Rahmes of Schenectady has been appointed a district sales manager for replacement tubes, and Gordon E. Burns, field sales manager of replacement sales for the Tube Department. Mr. Rahmes will make his headquarters at the Tube Department's eastern regional sales offices at Clifton, N. J.

The appointment of Sidney G. Stevens as manager of marketing for the specialty refrigeration department in Louisville, Ky., was announced.

Frank B. Gray was named manager of sales for air conditioners in Louisville replacing R. Dail Moore who recently was transferred to Schenectady, N. Y.

New RCA Appointment. Paul Bergquist, well-known broadcast consultant, has been appointed field sales representative for RCA broadcast equipment in Maryland and Virginia. From October 1946, until he received this appointment, he was a partner in the consulting firm of Gillett and Bergquist. Mr. Bergquist will have his headquarters in RCA Victor's Washington, D. C., office at 1625 K Street, N. W.

New Factory Branch. In order to expand its West Coast service, the Automatic Switch Company (ASCO) of Orange, N. J., will open a factory branch at 923 East Third Street, Los Angeles 13, Calif. This branch will stock a wide variety of solenoid valves and electromagnetic control, and will function as the ASCO West Coast service center.

New Appointment. General Cable Corporation has appointed William B. Bisker as advertising and sales promotion manager. Previously he was sales promotion manager for Lever Brothers. Before that he was with the du Pont Company in their Plastics Division advertising and sales promotion unit.

Raytheon Notes. Raytheon Television and Radio Corporation, formerly Belmont Radio Corporation, of Chicago, Ill., and Owlwein, Iowa, a wholly owned subsidiary of Raytheon Manufacturing Company, Waltham, Mass., will be merged into the parent company as of the close of business May 31, 1953. The new fiscal year begins on June 1, 1953, and the merger will be made to coincide with this.

The appointment of Henry F. Argento as vice-president and general manager of Raytheon Television and Radio Corporation, Chicago, a subsidiary of Raytheon Manufacturing Company, Waltham, was announced.

Cope Appointment. William S. Taylor recently was added to the sales engineering staff of T. J. Cope, Inc., Philadelphia, Pa. The company manufactures Cope Cable Trough for electrical cable installations and Instrof for installing instrument tubing. Mr. Taylor will make his headquarters in Philadelphia.

Territorial Changes. Holophane Company, Inc., announces the following changes in territorial coverage, effective April 1: Daniel R. Donnelly, New York district manager, servicing the greater metropolitan area in co-operation with Edward L. Gluck and Willard L. Warren; Robert W. Stanley, district manager in Connecticut and western Massachusetts, with headquarters in Hartford, Conn.; and Adriaan Van Oss, district manager in Michigan, with headquarters in Detroit.

Distribution Manager Named. Appointment of Donald A. Stewart as distribution manager for the Television Transmitter Division of Allen B. Du Mont Laboratories Inc., has been announced.

Lenkurt Electric Names Engineering Representative. Robert E. Graham has been named engineering representative in the Sales Engineering Division of Lenkurt Electric Company, San Carlos, Calif., manufacturers of telephone and telegraph carrier and radio equipment.

Production Starts in New IRC Plant. On March 13, 1953, the International Resistance Company, Philadelphia, Pa., started transferral operations to move a portion of its production facilities to a recently built, modern plant situated on a 66-acre site in Asheville, N. C. Production is already underway in the spacious $200,000 plant of the various types of volume controls used in radios, television sets, phonographs, testing equipment, military equipment, and numerous other devices.

Change of Address. F. M. Ballou, Manufacturer's Representative for the

(*Continued on page 22A*)

"When a new high voltage system was planned by the American Gas & Electric Service Corporation, Locke was given an opportunity to participate in the early development stage . . . and follow through to the conclusion," explains Bob.

"Our first job was to cooperate in the company's TIDD 500 kv transmission research project. At this voltage, one of the big problems was corona suppression. The pictures show the special products Locke developed to help the company lick this problem.

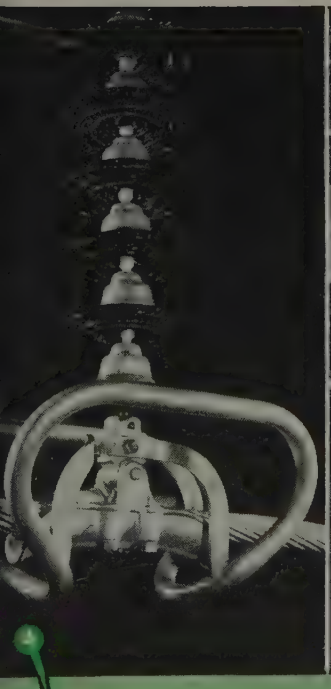
"After the experimental TIDD tests were completed, it was decided that 330 kv best suited the system's requirements. Naturally, this called for a re-study of the whole problem with emphasis on reducing size and cost, as well as how to make hot line maintenance work easier and safer. Here again the pictures show you what Locke did to help AG&E lick the problem.

"In my opinion," observes Bob, "this is an outstanding case of how Locke can . . . and does . . . provide unusual and often most unexpected services for its customers. And remember—all of these 'service extras' are included in the regular price you pay for Locke insulators.

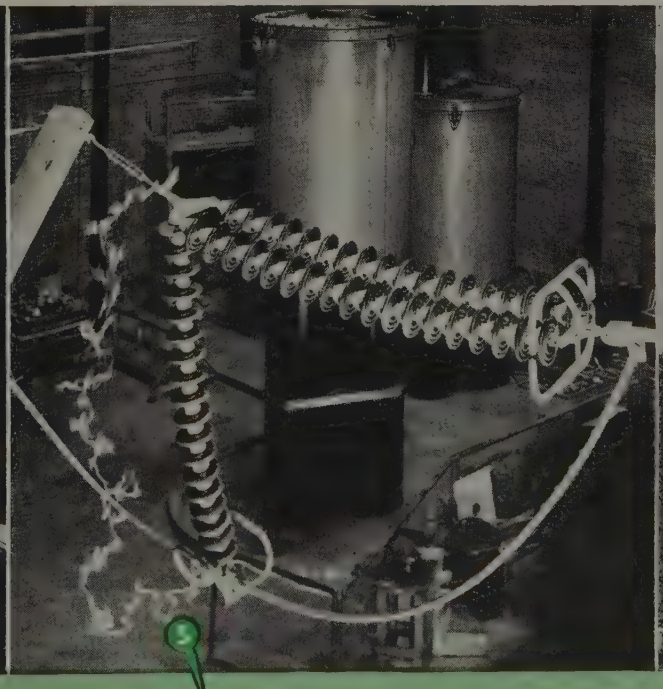
"So whenever you run into a problem of insulator design or application," urges Bob, "bring it to Locke. Your problem will be solved with the aid of one of the world's finest high voltage and mechanical research and development laboratories . . . staffed by engineers who are experts in the design and operation of insulators, as well as associated fittings."

LOCKE

LOCKE DEPARTMENT
GENERAL ELECTRIC COMPANY
BALTIMORE, MARYLAND



Hot Line Work Made Easier and Safer—At the conclusion of the TIDD tests, it was decided that 330 kv best suited the system's requirements. The entire problem was re-studied with an eye toward reducing size and cost and to make hot line maintenance easier and safer. The light weight, aluminum corona shields which can be removed and replaced on the suspension strings by removing only one self-locking nut was Locke's answer to the hot line maintenance problem.



Shield Removal Made Easier—In the case of the dead-end strings, Locke developed shields which can be removed and replaced by removing only two self-locking nuts. Instead of the shield being made in two halves, a one-piece shield was developed having an opening on the under side to clear the jumper loop. This one-piece shield was supported by two supports from the upper side with which bolts for attaching to the strain yoke were made integral.

Lines Now Operating—Today the first of these extra high voltage lines is in operation at 138 kv on the system of the Appalachian Electric Power Company. Half of this line is Locke equipped. Based on Locke laboratory tests made on the Tidd Line, the company has complete confidence that the lines will perform as expected when the new 330 kv service is made available. Locke welcomes unusual opportunities like this to assist its customers.

(*Continued from page 18A*)

Nelson Electric Manufacturing Company, has opened a branch office at 300 South Broadway, Room 512-A, Camden 3, N. J. J. Boylston Campbell, who has been with F. M. Ballou for the past year, has been appointed to this office.

NEW PRODUCTS • •

Radio Tube Finds New Uses. Important cost savings in the design and operation of ultrahigh-frequency and very-high-frequency television transmitters result from the application of a potent, versatile beam power amplifier tube which was introduced last year for use primarily in mobile radio and amateur communications, the Tube Department of RCA Victor reported. Developed by RCA engineers, the tube (*RCA-6146*) is finding a wide range of applications in new ultrahigh-frequency and very-high-frequency television transmitters being produced by several equipment manufacturers. It is being used in radio-frequency amplifier circuits, tripler circuits, and video amplifier circuits. Operating economies stem chiefly from this tube's efficient production of power at the higher frequencies, its low driving-power requirements, and its small size. In video use, it can handle high plate current without drawing grid current. This characteristic leads to a simplification of the video amplifier, since it does not have to be designed to provide grid current for the modulator stage. Engineered to operate efficiently at relatively low plate voltage, the company reported, the "mighty midget" tube has also found widespread amateur application on all bands, including the 2-meter band, during the 12 months it has been on the market.

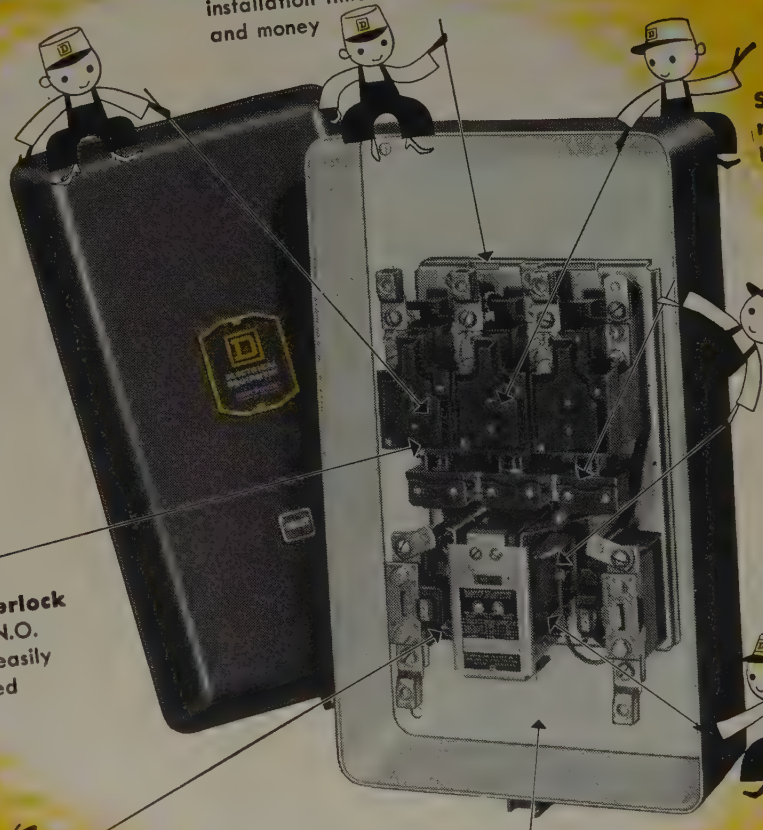
Dual-Rated Transformer. Production of a new dual-rated dry-type heatproof insulated transformer that takes overloads for far longer periods has been announced by Marcus Transformer Company, Hillside, N. J. The transformer earns the double rating as a result of blowers mounted in the housing, and a thermostat located in the coils. One rating covers its operation without the blowers functioning, at which time the transformer is naturally cooled. When heat reaches a certain level the thermostat activates the blowers, and this provides scientific forced-air cooling that automatically increases the transformer's rating by $33\frac{1}{3}$ per cent. Baffles in the housing direct the moving air over and through the coils. Air vents are located front and rear, top and bottom. Available in ratings from 100 to 3,000 kva in voltages to 15,000 volts.

New General-Purpose Relays. A complete new line of general-purpose relays, featuring longer life and greater flexibility of application, has been announced by the

(*Continued on page 28A*)

NEW Square D Size 4 Starter

Feature-packed!



"Hook-on" base design saves installation time and money

Special sintered metal contacts last longer

High arc-interrupting capacity with "magnetic yoke" arc chamber

Coil and contacts removable from front **without disturbing power wiring**

Up to 8 interlock circuits (4 N.O. and 4 N.C.) easily front-mounted

Permanent air-gap lengthens magnet life

New coil holder simplifies coil change

All parts front-mounted for easy service and maintenance

The highest degree of accessibility, flexibility and compactness—with no sacrifice of performance and long life. That's Square D balanced design—and you'll find it in every size Square D starter.

"Off-the-Shelf" Parts Kits, another Square D convenience feature, make normal maintenance easier than ever. Each kit contains parts to replace all load contacts and finger springs. Electrical interlocks also available in kit form.

Write **for Bulletin 8536, Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin**

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

SQUARE D COMPANY

1903 • **50** YEARS OF DESIGN LEADERSHIP • 1953

(*Continued from page 22A*)

General Electric Company's Control Department. Operating life of the new relays has been greatly extended by use of a braided shunt and repositioning of the shunt to reduce tension and wear. Use of the standardized open-form relays with conversion kits, provides units with greater utility and permits reduction in inventory. Conversion units are available for metal and compound base backmounting, base receptacle, relay jack-plug applications, and explosionproof enclosures for dust-tight and Class *1*, Group *D* service. The new relays, designated as *CR2790-E*, are rated from 6 to 300 volts; 60, 50, and 25 cycles plus direct current; and 10-ampere continuous-contact rating. Contact arrangements include double-pole single-throw, double-pole double-throw, and single-throw double-break. The relays may be used as starters for small a-c motors where motors have sufficient overload protection. They also are especially suitable for electronic equipment and air conditioners, where small space and long relay life are major factors.

Precision Wirewound Resistors. New "*G*" type precision resistors developed by the Shallcross Manufacturing Company, Collingdale, Pa., utilize the heat-resistant properties of fiberglass insulated wire to increase wattage ratings 5 to 10 times over those of commercial precision wirewounds of the same dimensions. For example, the new Shallcross Type *G-196E* will dissipate 8 watts in comparison with the 1-watt rating of the standard Shallcross Type *196* resistor. After winding with the special glass-insulated low-temperature-coefficient wire, the resistors are silicone-impregnated for stable high-temperature operation. This permits "*G*" resistors to be conservatively rated for a 150-degree-centigrade temperature rise above an ambient of 25 degrees centigrade. The resistors are particularly useful in industrial and military equipment operating at high temperatures and for applications requiring noninductive precision power resistors. They are available in all standard bobbin sizes and with wattage ratings from 1 to 20 watts. Further details are available on letterhead request to the manufacturer.

"Ken-Seal" Molded Transformers. A new line of molded transformers marketed under the name "Ken-Seal" has been announced by Kenyon Transformer Company of 840 Barry Street, New York, N. Y. They intend to supply the demand for units of exceptionally light weight, small size, and low cost without any sacrifice in hermetic sealing or other efficiency. Molding process was chosen in preference to dipping or encapsulation because it accomplishes this and in addition produces a product which is uniform and controllable to definite dimensions.

New Generator. The Hewlett-Packard Model *618B* Signal Generator is designed

(*Continued on page 34A*)

looking into the future of BAKELITE POLYETHYLENE wire covering

TRADE-MARK

The picture above shows samples of BAKELITE Polyethylene being subjected to intense sunlight, day-night effects, and rain — years of exposure crammed into hours — showing evidence of the long-term service to be expected from this great advance in wire and cable constructions.

After this treatment, they will be tested for such features as tensile strength, abrasion resistance, and low temperature flexibility—properties important to their use as wire covering and insulation.

The picture to the right shows wires, covered with black BAKELITE Polyethylene, that have been exposed for years to actual outdoor weathering. There has been no sign of cracking or crazing.

s is just one series of tests made on BAKELITE Polyethylene naintain quality and to prove its durability. This superior e covering resists chemicals, oil, water immersion, abra-. The approved black compound stays flexible down to) deg. C., resists deformation up to 90 deg. C. It meets A suggested specifications (second draft: July 20, 1952) weather-resistant wire and cable.

AKELITE Polyethylene, extruded onto wire, won't festoon. rovides a thin, smooth-surfaced covering that speeds strip- and splicing. Its low specific gravity, only 0.92, means ter weight—easier stringing.

abelitems #48 gives detailed information on BAKELITE ethylene. For your free copy, write Dept. QB-66.

OUTSTANDING ELECTRICAL PROPERTIES for signal systems and service drop, wet or dry — at 50 megacycles and 25 deg. C., power factor is only 0.0005; dielectric constant only 2.35. These values hold through the range from 60 cycles to 5×10^7 cycles. Operating temperatures up to 90 deg. C. have little effect on electrical properties. Insulation resistance is too high to measure on conventional testing devices. BAKELITE Polyethylene excels in resistance to voltage breakdown, even after long-time water immersion.

BAKELITE
TRADE-MARK
POLYETHYLENE
WIRE COVERING

AKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

(*Continued from page 28A*)

for faster, more accurate measurements of radio-relay, radar, television carrier systems, and similar applications involving superhigh frequencies. It is equipped with a reflex klystron oscillator for frequency generation. Accuracy and stability is high throughout the continuous frequency range of 3,800 to 7,600 megacycles. Frequency and voltage are directly set and read. Dial tuning is tracked automatically, and no voltage adjustment is required during operation. The equipment offers wide pulsing capabilities. It may be internally or externally pulse modulated. Repetition rate is continuously variable from 40 to 4,000 pulses per second. Pulse width is variable from 0.5 to 10 microseconds and also may be synchronized with an external sine wave, or with positive or negative pulse signals. For further information, write Hewlett-Packard Company, 395 Page Mill Road, Palo Alto, Calif.

Splice. A new splice that requires conductors to feed through the jaws has been developed by Reliable Electric Company, Chicago, Ill. The "*55*" Series Straightline Splice is made of copper and copper alloys for copper conductors, and aluminum and aluminum alloys for aluminum conductors. Said to appear conventional externally, the new splice has openings only at tube ends, and even they are closed by pilot cups until conductors are inserted. The cups are factory installed in each end of the splice. They await the conductors and guide them "home." Pilot cups prevent a premature or false grip. Once the cups with conductors have been run through to center stop, the installation is complete and positive. Some of the advantages of the splice are: the pilot cups make it impossible for the jaws to grip conductor, unless conductor is properly "home"; it feeds through readily with a definite "feel" and "sound" when conductor strikes home; bent or out-of-lay strand or burred conductors cannot catch in the jaws; complete closure prevents entrance of gritty materials known to obstruct action of sliding tapers. For further information, contact F. A. Leach, manager, Specialty Sales, Reliable Electric Company, 3145 Carroll Avenue, Chicago 12, Ill.

Molded Composition Potentiometers. Dual Type *AB* molded composition potentiometers, consisting of two units mounted in tandem and controlled by the rotation of one shaft, are now being offered by Ohmite Manufacturing Company, Chicago, Ill. These 2-watt potentiometers are designed for industrial, laboratory, and radio, television, and electronic service applications where reliability is particularly important. The resistance element is a thick, solid-molded ring, heat treated under pressure, not a sprayed film of paint-type resistor. The new dual units have a 2-inch-long round shaft, and independent electric connections. For a complete description and dimensional

(*Continued on page 40A*)

THIS IS A 150 Kv ANTENNA ENTRANCE INSULATOR

This insulator is designed to carry an antenna lead through the roof of a transmitter tuning house to an antenna. It is used at an effective operating voltage of 150 kv, and is the largest insulator of this type ever built—requiring a porcelain dome 32″ in diameter, 30″ high. It is similar to the Lapp standard series of antenna entering insulators for the broadcast industry, but is something "special" indeed in size—Lapp's answer to a demand from the field for an insulator to be operated at a voltage considerably higher than previously encountered in broadcast practice.

This design is significant, in addition to its large size, for the ingenuity of its shielding provisions. The porcelain is protected against dielectric heating internally, opposite the flange, and externally, at the narrow top section.

Many suppliers of equipment to the electrical transmission, as well as radio industries, look to Lapp for engineering, design and production of special parts involving use of high-voltage or low-loss ceramics. They know, as do operators of transmission and distribution systems across the nation, that the name LAPP guarantees an extra margin of operating security. For, although *you can buy cheaper porcelain—you can't buy better porcelain*—than LAPP.

Lapp Insulator Co., Inc., Le Roy, N. Y.

Lapp

(*Continued from page 34A*)

drawings of these potentiometers, write to Ohmite Manufacturing Company, 4897 Flournoy Street, Chicago, Ill., requesting Bulletin *131B*.

Ultrahigh-Frequency Transmitting Antenna. A new 2-bay 24-wave-length-section slot-type ultrahigh-frequency transmitting antenna has been announced by the Television Transmitter Division of the Allen B. Du Mont Laboratories, Inc., Clifton, N. J. The new antenna has been cataloged as the Type *5327-A*. Outstanding among the many features is the uniform coverage provided throughout the desired area, as required in most installations. The vertical beam of the antenna approaches within 6 decibels of the ideal distance versus signal strength cosecant curve. The antenna can be electrically and mechanically tilted to provide the vertical pattern desired in any particular installation as Type *5327-A* (modified). In this manner, the basic Du Mont antenna design can be used for installations usually requiring expensive custom-designed antennas.

Fiberglas Duct Liner. A new Fiberglas insulating product for lining the interior of air-conditioning or warm air ducts has been introduced by Owens-Corning Fiberglas Corporation, Toledo, Ohio. Known as Flexible Duct Liner, the insulation has a high noise reduction efficiency and thus effectively reduces sounds that normally travel through air ducts. It also has excellent thermal insulating properties and when used inside of ducts allows the metal surface to act as a vapor barrier, thus preventing condensation on those ducts carrying cool air through areas of high humidity.

Heavy-Duty Rotary Switches. Two single-deck single-pole rotary switches designed for complicated range or circuit switching of experimental apparatus or heavy-duty test equipment, have been announced recently by the Shallcross Manufacturing Company, Collingdale, Pa. Both the 60-position (Type *10061-S*) and the 36-position (Type *10054-S*) models have a unique detent mechanism which also provides the non-short-circuiting action. The rotor arm is actually lifted as it moves from one contact to the next thus allowing the maximum number of usable contacts in the smallest space. Large solid silver contacts mounted on a laminated phenolic deck result in an average contact resistance of less than 0.006 ohm. The current-carrying capacity of the Type *10054-S* is 40 amperes, with breakdown voltage of 2,500 volts. The 60-position Type *10061-S* will carry 30 amperes, and has a breakdown of 1,500 volts. Further details are available on letterhead request to the manufacturer.

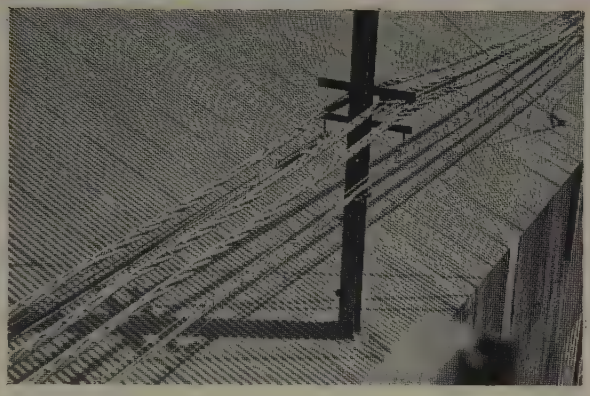
Function Plotter. The ElectroniK Function Plotter can be used to advantage

(*Continued on page 52A*)

means... what?

REPEAT PERFORMANCE. This first motor-operated electric semaphore signal was powered through Okonite—as is today's modern counterpart on the same site.

MULTIPLE INSTALLATIONS. Installed in 1941, these 34.5 kv Okolite submarine cables supplement an existing pair of 34.5 kv cables installed in 1931.



AERIAL. Okolite-Okoprene self-supporting cables can be installed quickly, easily and economically.

UNDERWATER. Okolite insulation requires no lead sheath even when totally submerged.

INDUSTRY. From power distribution to production machinery, Okonite cables play an important part in industry.

TRANSPORTATION. Classification yards, powerful diesels, signal systems, and passenger cars depend on Okonite cables for uninterrupted service.

• ***products of on-the-job experience***

75th ANNIVERSARY

(*Continued from page 40A*)

wherever there is occasion to depict graphically one variable as a function of another ($y=f(x)$). It plots such curves with speed and accuracy. Measurements over the entire curve are continuous, and it is not necessary to interpolate to complete data between points of measurement. This saves much time in investigation involving interdependent nonlinear variables. The measuring circuit of each axis can be energized by any d-c source, so that a wide variety of investigations can be made. Direct inquiries to Station 64, Minneapolis-Honeywell Regulator Company, Wayne and Windrim Avenues, Philadelphia 44, Pa.

TRADE LITERATURE

Selection Guide. Tips on selecting the right starter for squirrel-cage induction motors rated up to 600 horsepower at 600 volts or less are contained in a new bulletin released by Allis-Chalmers Manufacturing Company. Information included in the bulletin tells how to select the proper type of starter, enclosure, and operating arrangement, and explains how to determine whether a full- or reduced-voltage starter should be used. An explanation of 2- or 3-wire control and hints on selection of heater elements for overload relays are also given in the bulletin along with a cage-motor starter selection chart. Copies of this Allis-Chalmers selection guide for general-purpose starters, *14B7733*, are available upon request from Allis-Chalmers Manufacturing Company, 931 South 70th Street, Milwaukee, Wis.

Permanent Magnets. Thomas & Skinner Steel Products Company, Inc., Indianapolis, Ind., has released a catalogue listing its complete line of standard permanent magnets. Available in Alnico *2*, *3*, and Alnico *5* for use in a wide range of industrial applications, Thomas & Skinner standard magnets may be ordered from stock to aid designers and engineers who want magnets quickly to produce working models for experimental purposes, to fulfill moderate production requirements, or to adapt to a standard application without tooling delays. For Standard Magnet Catalog Number *1252* write to Thomas & Skinner Steel Products Company, Inc., 1154 East 23d Street, Indianapolis 5, Ind.

"Mylar" Polyester Film. A new technical bulletin containing up-to-date information on the physical, electrical, and chemical properties of "Mylar" polyester film, and suggested applications, has been issued by the du Pont Film Department. First of a series to be issued on "Mylar," the new 14-page bulletin (number *1-2-53*) is complete with charts, diagrams, and tables. In addition to a detailed table on the physical properties, the bulletin compares these properties with those of the other

(*Continued on page 54A*)

RUGGED

DEPENDABILITY of ANDERSON

DISTRIBUTION CONNECTORS TYPES 'K' & 'KR'

MEANS UNINTERRUPTED POWER SERVICE

7 OUTSTANDING SERVICE FEATURES:

- Each component is of a special alloy for high strength, and achieves a specific electrical and mechanical function.
- Flexing arch type clamping members retain high pressure contacts on cables during vibration and temperature changes.
- Transmits high pressure contacts from connector clamping members through each cable strand to core wire.
- Limits high resistance oxide formations on connector contact and cable interstrand contact surfaces.
- Eliminates connector failures resulting from heavy short circuit current surges passing through oxide contamination on connector and cable interstrand contact surfaces.
- Withstands Mercurous Nitrate Specification ABW-124-1* which insures against seasonal and stress corrosion cracking failures.
- Two styles, "KR" with conductor spacing bar, "K" without. Both "K" and "KR" series include 7 sizes for cables from #8 to 1000 MCM.

* Identical to ASTM B-154-45 Mercurous Nitrate Specification except ABW-124-1 specifies stressed components which is a more severe test.

WRITE TODAY... for Bulletin K-175 containing complete data on Anderson Distribution Connectors Types "K" and "KR"

OR CONSULT YOUR NEAREST ABW REPRESENTATIVE.

Aluminum and Bronze
POWER CONNECTORS
•
CLAMPS
•
FITTINGS and ACCESSORIES for
SUBSTATION — TRANSMISSION — DISTRIBUTION

ABW

ANDERSON BRASS WORKS
INCORPORATED
BIRMINGHAM 1, POST OFFICE DRAWER 2151 ALABAMA

(*Continued from page 52A*)

du Pont films: cellophane, polyethylene, acetate. One section gives complete information on the film's electrical properties: dielectric strength, insulation resistance, volume and surface resistivity, and so forth. The chemical properties section shows the tensile strength and tear resistance of "Mylar" upon exposure to solvents, acids, and other chemical reagents. Copies may be obtained from the du Pont Film Department's Sales Development and Technical Service Section, Wilmington 98, Del.

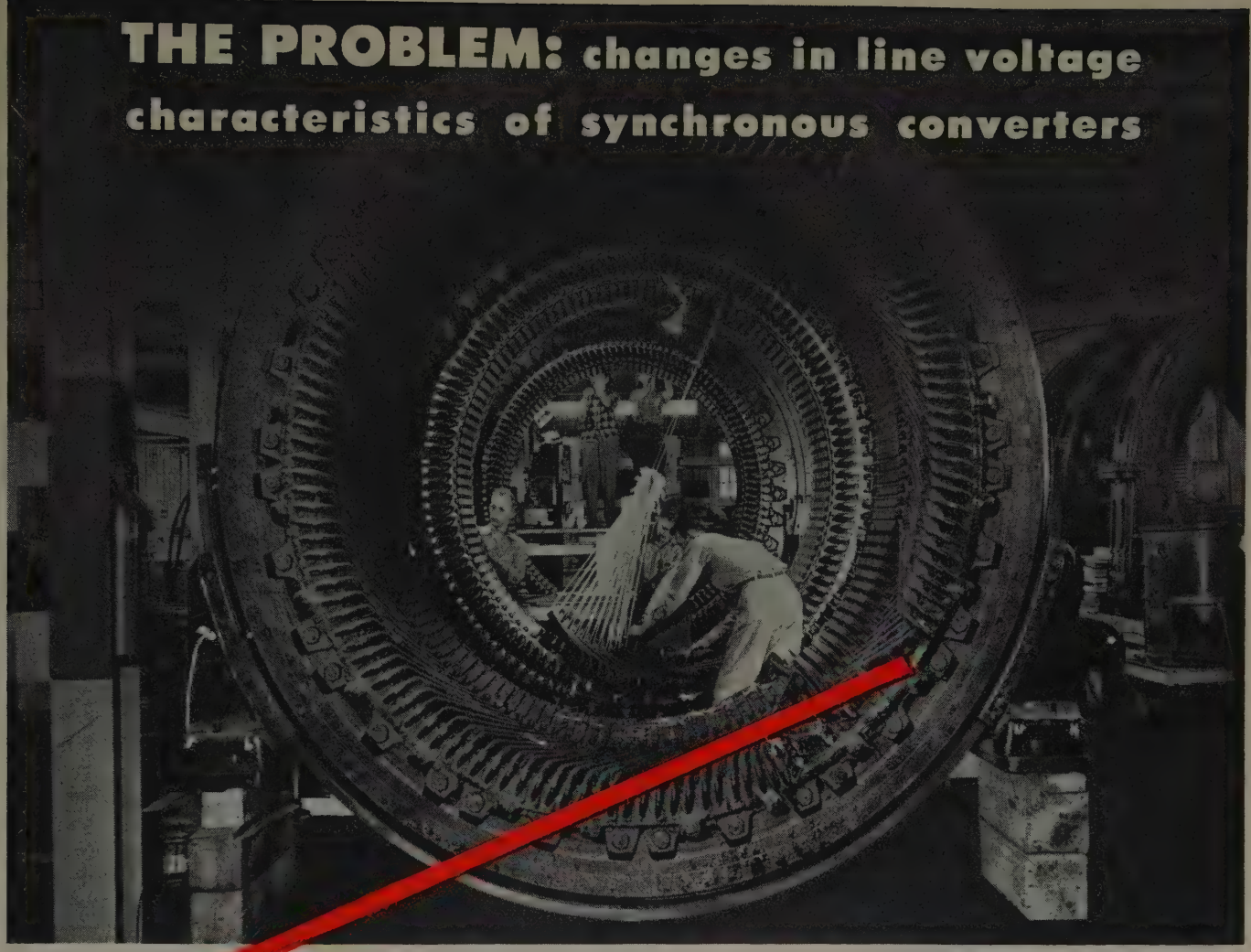
Motor-Generator Reference Booklet. A motor and generator reference booklet to assist in the selection of motive power to handle most industrial applications is being made available by Allis-Chalmers Manufacturing Company. The 50-page pamphlet is reprinted from the 1952 edition of Lincoln's Industrial-Commercial Electrical Reference published by the Electrical Modernization Bureau, Inc. Text and illustrations on integral-horsepower motors and generators for the book were furnished by Allis-Chalmers in co-operation with the Electrical Modernization Bureau. Copies of "Allis-Chalmers Motor and Generator Reference Book," *51R7933*, are available on request from Allis-Chalmers Manufacturing Company, 931 South 70th Street, Milwaukee, Wis.

Lamp Catalogue. A new, full-color Large Lamp Catalogue has been announced by General Electric's Lamp Division, with headquarters at Nela Park, Cleveland, Ohio. Entirely new in format, the 72-page catalogue replaces a volume published in 1948. It is the most elaborate and complete lamp catalogue yet to be issued by General Electric. Purpose of the catalogue is to show and describe briefly the popular types of G-E lamps available for many important lighting services. Buyers and sellers of lamps are expected to find it of great assistance in determining sizes and types needed, and for properly identifying individual lamps. The publication presents much information about the construction, operation, and application of lamps for the guidance of the book's users. Carrying a price of 70 cents, the Large Lamp Catalogue is intended for persons interested in lamps and lighting in a professional or business way.

Electron Tubes. An up-to-date "Who's Who" of RCA electron tubes which describes 495 different receiving types and kinescopes is available from RCA tube distributors. The new booklet entitled, "RCA Receiving Tubes for AM, FM, and Television Broadcast" (Form Number *1275-F*), was designed to provide service dealers with an up-to-date catalogue of RCA receiving tube information and to serve as a guide to the selection of the most suitable tube for a given application. Contained in the 24-page booklet are characteristics of each of the 495 tube types, together with socket connection diagrams arranged for quick and easy reference. Information on RCA television picture tubes is presented in a special chart which

(*Continued on page 62A*)

THE PROBLEM: changes in line voltage characteristics of synchronous converters



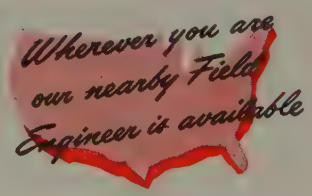
National has the answer

National engineers weren't stumped when a customer needed increased voltage from four synchronous converters. National redesign, made effective by National rewinding and National insulating materials, produced the required increase without loss of capacity.

In answer to another synchronous converter problem, National engineers proposed substantial voltage reductions which resulted in a 26% increase in the capacity of the National-rebuilt sets.

National engineers can redesign your apparatus to enable it to meet changing requirements. National craftsmen, working with National materials, can handle any rewinding job. National field engineers will supervise on-the-spot rebuilding of equipment too big to ship.

If you have a problem with any piece of rotating electrical equipment, it will pay you to consult National.



NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A.

TRADE MARK

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—
REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

(*Continued from page 54A*)

lists and describes 45 types. Each type is listed in numerical-alphabetical sequence, according to its type designation.

Dictionary of Carrier Terms. Definitions of 150 terms commonly found in telephone and telegraph carrier equipment literature are given in the Lenkurt Bulletin *EB-101*, "A Dictionary of Carrier Terms." The 16-page booklet also includes a general discussion of carrier equipment theory. Copies of this new publication are available from: Lenkurt Electric Company, 1101 County Road, San Carlos, Calif.

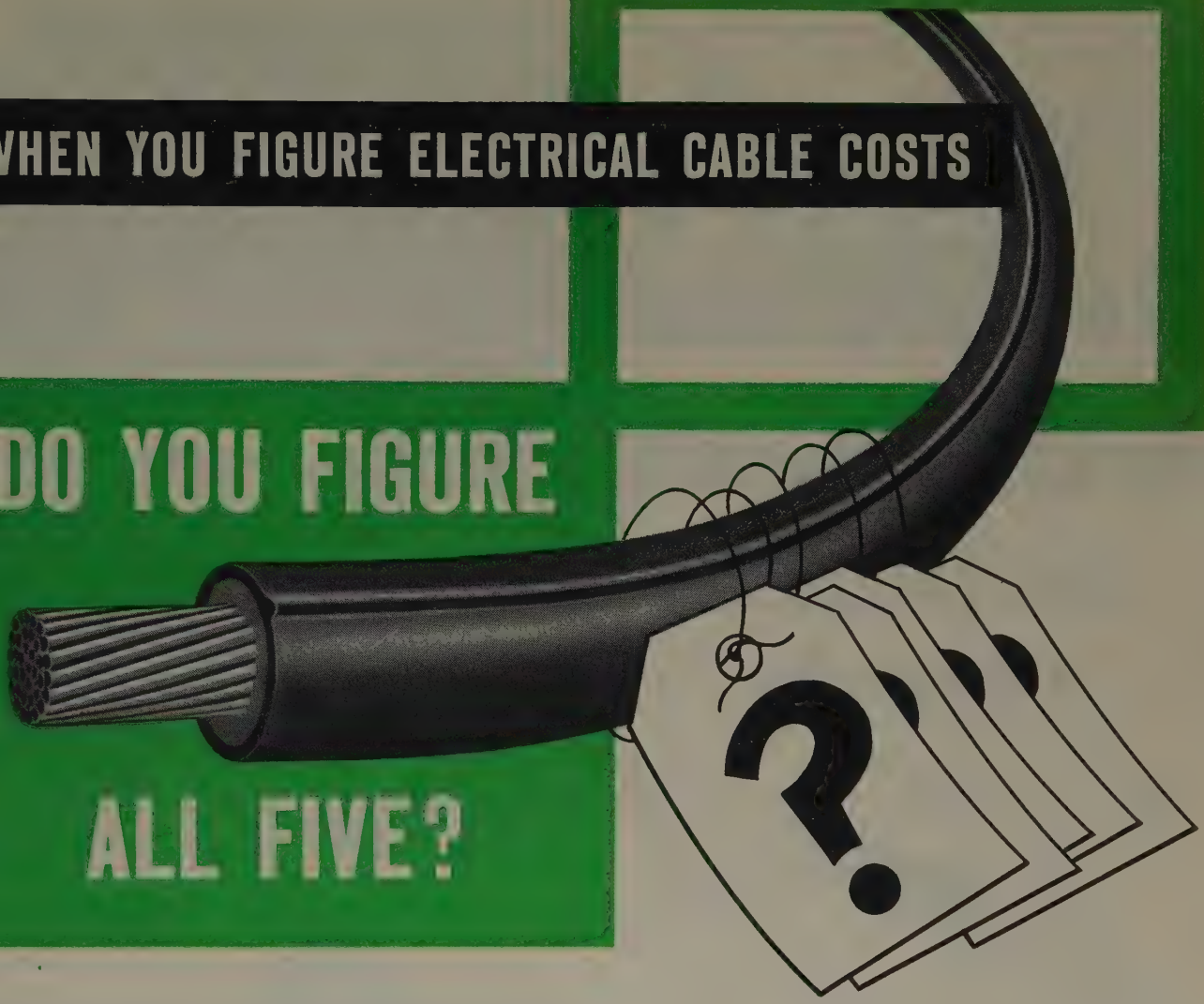
Transformers. A new line of hermetically sealed transformers, designed to *MIL-T-27* specifications, in *MIL-T-27* standard steel cases, is announced by Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y. These are high-vacuum impregnated, fully tested and guaranteed. They include the specific types chosen for universal military applications, and cover a wide specification range. In the line are military standard filament transformers, military standard audio types, and also filter reactors. Detailed specifications and prices on types in the new line are contained in this new catalogue.

Control Relay. Application and design information about the recently introduced Type *N* control relay is available in booklet form from the Westinghouse Electric Corporation. Designed for remote-control operation, this new relay is used to sequence multimotor machines, to operate solenoids, and to obtain pilot control from push-button stations of electric circuits associated with such functions as temperature and pressure regulation. The Type *N* relay has a 10-ampere open rating, up to 600 volts and 6 poles, and is available in any normally open–normally closed combination. An exploded view of the relay shows its construction features as well as how easily it is disassembled. Also, pictorial instructions show how to obtain the combinations of normally open–normally closed contacts. A dimensional drawing of the relay and associated wiring circuits are provided. For a copy of this booklet, *B-5817*, write Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa.

Arcaloy Stainless Steel Electrodes. A new 20-page catalogue in color is offered by the Alloy Rods Company on its complete line of Arcaloy Stainless Steel Electrodes. The catalogue includes explanation of the two basic types offered, lime coating for all-position welding with d-c reverse polarity, and alternating current–direct current for welding of chrome-nickel steels with all types of a-c or d-c welding equipment; individual descriptions of the 23 regular analyses and special analyses of Arcaloy electrodes, weld metal properties, welding procedures, electrode analysis and color charts, current ranges, and American Iron and Steel Institute type numbers. Copies of this catalogue may be secured by writing Alloy Rods Company, York, Pa., and asking for Bulletin *AR53-16*.

WHEN YOU FIGURE ELECTRICAL CABLE COSTS

DO YOU FIGURE ALL FIVE?



All too often electrical cables are purchased solely on the basis of initial cost. Actually, of course, this is only one of five factors to consider . . . and no true cost comparison can be made until the four "hidden" costs are figured.

Here are the four "hidden" costs which often upset your overall budget, particularly when you're trying to "economize":

- **installation costs**
- **maintenance costs**
- **costs of power shutdowns when a cable fails**
- **costs of replacing a cable which has failed prematurely.**

Okonite cables are the most effective means for combating these costs. A wide range of Okonite cable designs assures you of the most economical installation for any type of operating condition. And for savings throughout the life of the cable, Okonite always uses the premium materials and exclusive processing techniques which deliver unfailing electrical service year in and year out.

We can't condense millions of man-hours of cable research, field engineering and manufacturing experience into a short description of Okonite cables. But your Okonite representative can show you in black and white why the best cables — Okonite cables — really carry the lowest overall cost. The Okonite Company, Passaic, N. J.

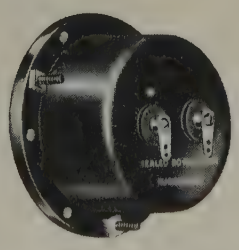
The best cable is your best policy

OKONITE SINCE 1878 *insulated wires and cables*

5809

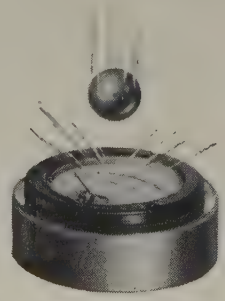
WESTON Ruggedized Instruments

have *EXCLUSIVE* zero correctors



Connection terminals molded into internal rubber increase current carrying capacity.

No desirable instrument features were sacrificed in order to produce these truly ruggedized and effectively sealed instruments. With typical WESTON thoroughness, every feature has been retained including even the zero corrector. And *true* ruggedness has been achieved by new but thoroughly proved design concepts, such as shock-resistant spring backed jewels . . . flat windows of tough, anti-static, and glare reducing plastic . . . new high-strength tubular pointers, and a method of shock mounting and sealing that assures accurate indications under extremes of shock, vibration, temperatures, humidity, and downright abuse. Available in 2½" and 3½" D-C, R-F, A-C movable iron and rectifier types. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

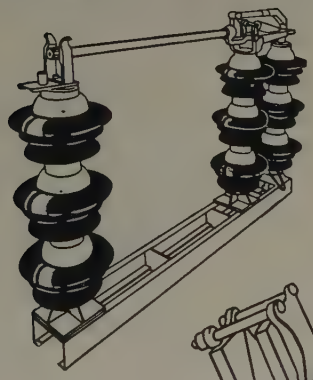


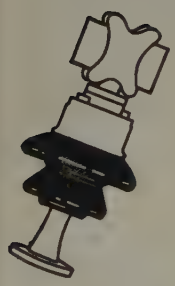
Tough, flat plastic windows reduce glare and are *really* shock resistant.

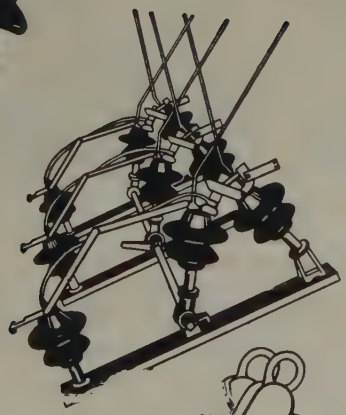
WESTON *Instruments*

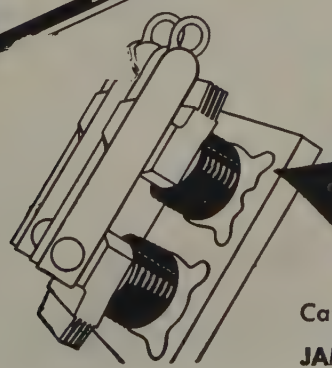
FOR DEPENDABLE TROUBLE-FREE PERFORMANCE

POWER SWITCHING EQUIPMENT









For over 40 years the Elpeco line of high-quality power switching equipment has been known for its outstandingly dependable and trouble-free performance. Constant research and redesign have enabled Elpeco to *anticipate* rather than meet the ever changing demands and requirements of the electrical industry. Particular buyers, who have specified Elpeco products over the years, know that when they buy Elpeco Indoor and Outdoor Disconnect Switches, Air Break Switches, Indoor and Outdoor Bus Supports, Bus Ducts and Substations . . . they are getting the finest, most modern equipment on the market. All Elpeco products conform to NEMA and AIEE standards for performance.

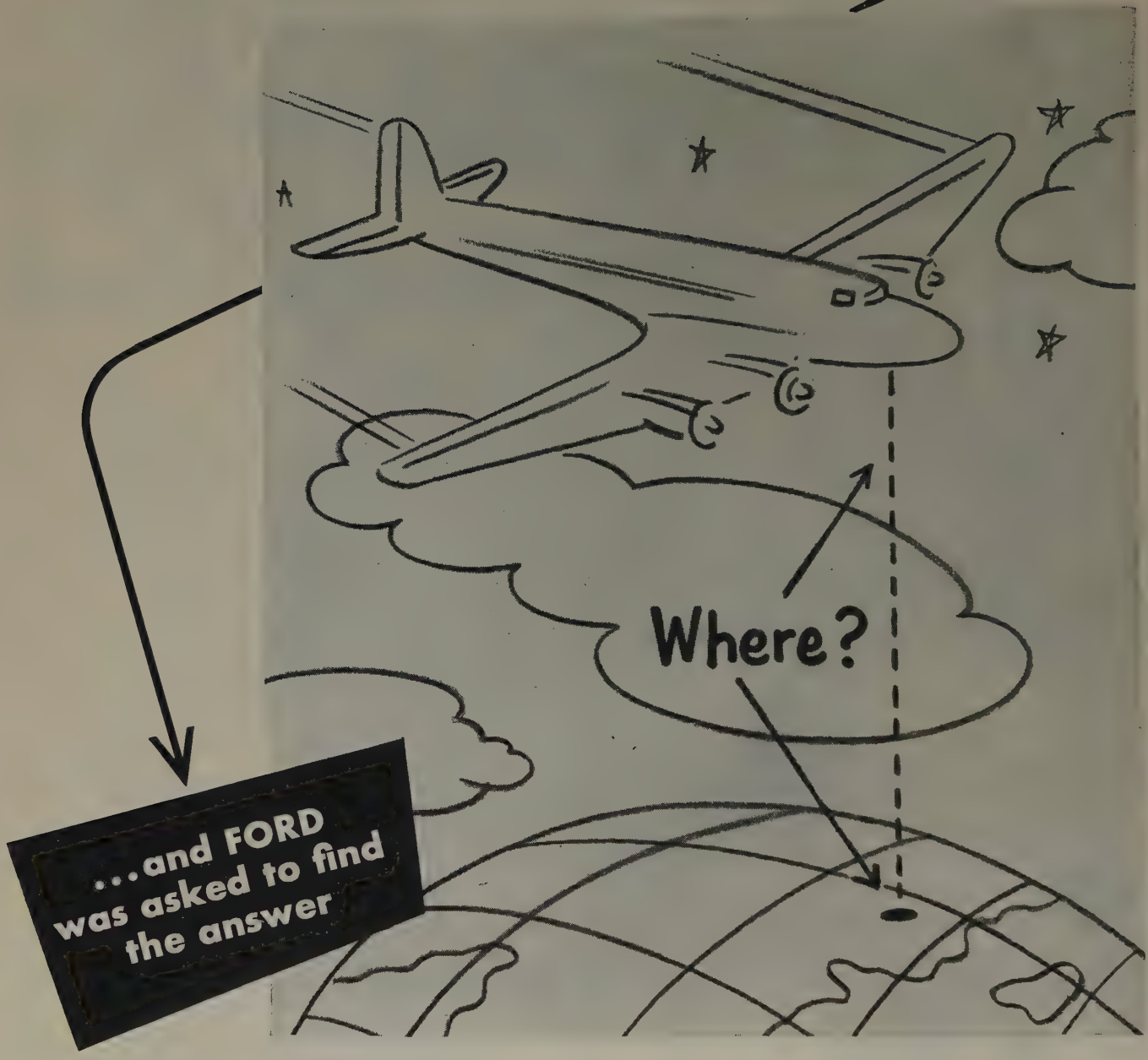
A new series of bulletins, completely illustrating and describing each item in the Elpeco line is now available. Let us know the particular type of equipment in which you are interested. We'll be glad to send the appropriate bulletins by return mail.

ELPECO

DIVISION OF ROLLER-SMITH CORP.
BETHLEHEM, PENNA.

Canadian Affiliate:
JAMES R. KEARNEY CORP. of Canada, Limited, Guelph, Ontario

TO INDICATE aircraft position with no ground-to-air communication



Combat mission . . . or freight flight . . . now we are working to help the pilot locate his position without a radio beacon – merely by equipment right in the cockpit of his plane! Thanks to a Ford Instrument Company design, development and manufacture . . . another step is being taken toward greater flying safety.

This is typical of the problems that Ford has been given by the Armed Forces since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic, electro-mechanical, magnetic and electronic instruments that bring us our "tomorrows" today. Control problems of both Industry and the Military are Ford specialties.

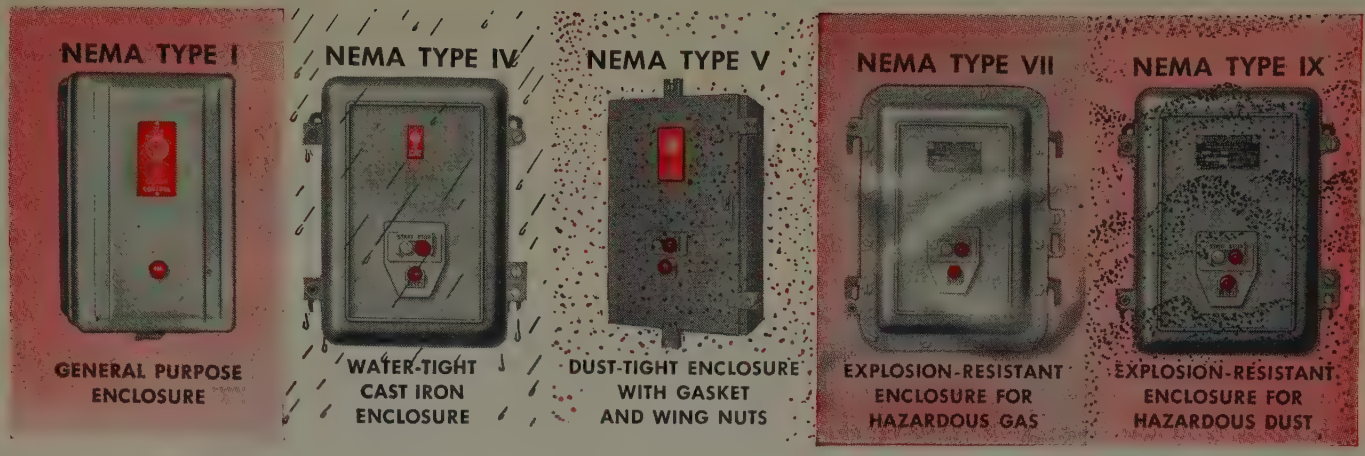
You can see why a job with Ford Instrument offers young engineers a challenge. If you can qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

9

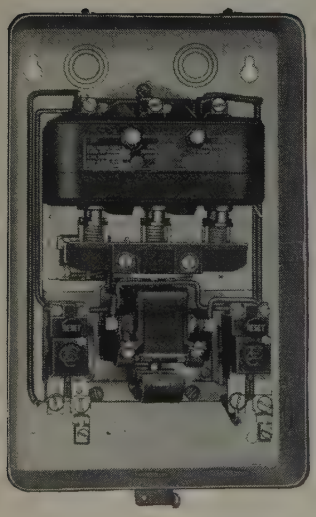
FORD INSTRUMENT COMPANY

DIVISION OF THE SPERRY CORPORATION

31-10 Thomson Avenue, Long Island City 1, N. Y.



for every operating condition
use CLARK TYPE "CY" STARTERS

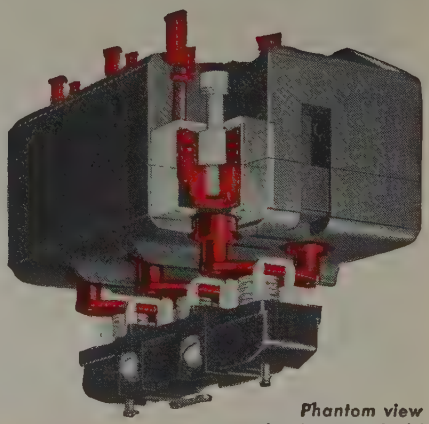


In every industry, including those where hazardous atmospheres prevail, CLARK TYPE "CY" STARTERS are giving utmost satisfactory service.

The incomparable new multi-turn magnetic blowouts combined with twin-break contacts, and the rest of the operating mechanism, are enclosed in types of cabinets to protect against adverse conditions or dangerous atmospheres.

Type "CY" starters, Sizes 2 and 3, employ an entirely new principle of arc interruption. The arc is extinguished by the effect of the blowout coil, concentric with the contact. The magnetic field quenches the arc either by lengthening or confining it. In its forced rotation it moves continually from a hot to a cold spot—minimizing burning or pitting of contacts. The ingenious design of the arc chamber prevents carbonization and the accumulation of hot gases between wiring terminals—minimizing phase-to-phase failures. Sizes 0 and 1 use the same general mill type construction as the larger sizes.

- **No filing, dressing or cleaning of contacts!**
- **No tools necessary to inspect contacts!**
- **Easy to change moving contacts!**
- **Stationary contacts changed quickly!**
- **Remove only two screws and one pin to change coils!**
- **Remove only four screws to take out stationary magnet frame!**
- **Power circuit contacts available with springs in complete packaged service kits for ease in stocking!**



Phantom view showing Arc-shield

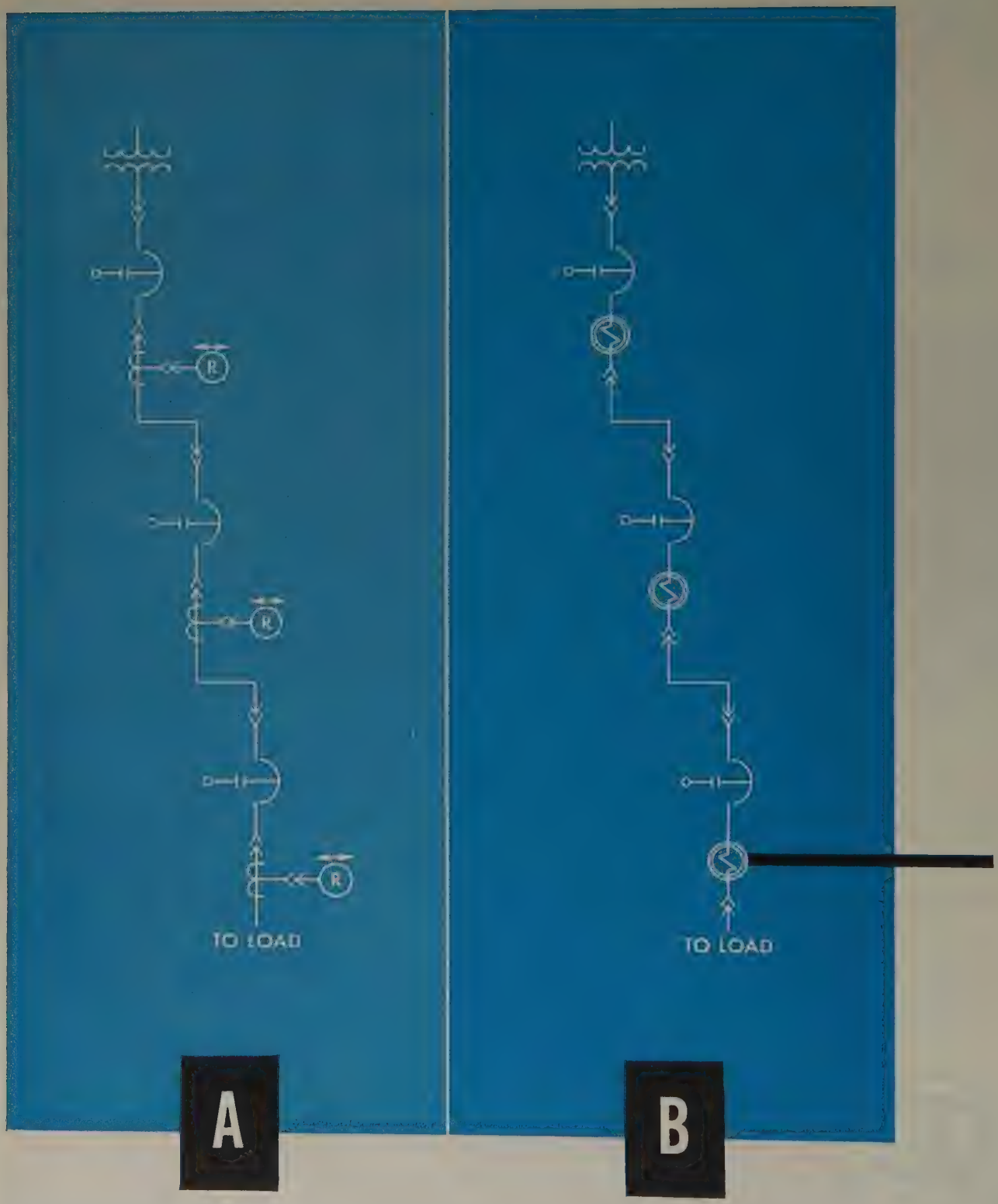
***You'd better try* CLARK TYPE "CY"**

ENGINEERED ELECTRICAL CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND STREET, CLEVELAND 10, OHIO

Both systems provide



selective trip circuit breaker protection

but this *direct-acting* device on I-T-E circuit breakers cuts initial cost and saves space

These two systems were designed to perform identical functions. System **(A)** is costlier, takes more space, and requires a greater degree of skill to maintain.

System **(B)** represents the latest thinking in low-voltage system reliability and introduces the use of I-T-E circuit breakers with direct-acting dual-selective overcurrent trip devices. Savings in initial investment, in space, and in over-all maintenance are achieved.

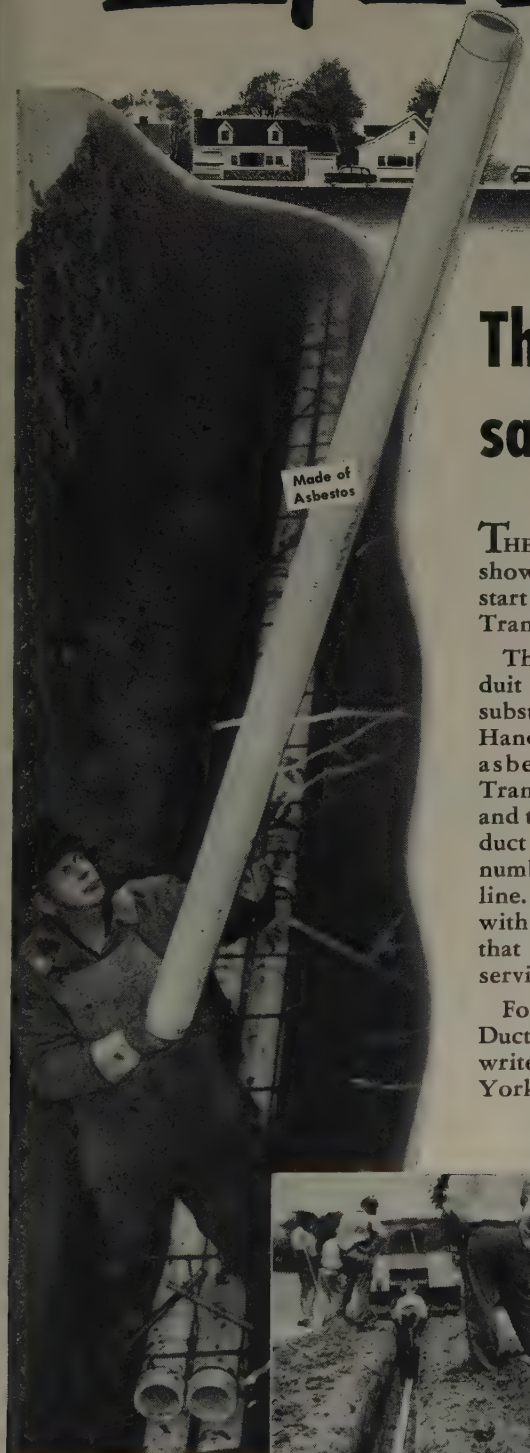
Recent installations in central stations, processing industries, and manufacturing plants have proved that I-T-E circuit breakers with direct-acting selective overcurrent trips should be carefully considered for every new installation.

LOW-VOLTAGE SWITCHGEAR

I-T-E CIRCUIT BREAKER COMPANY • 19th & Hamilton Sts. • Philadelphia 30, Pa.

EPD—CANADIAN MFG. & SALES: EASTERN POWER DEVICES, LTD., TORONTO

Easy to install...



That's why TRANSITE DUCTS save time, labor and money

THESE "ON THE JOB" photographs show why savings begin right at the start of the installation when you use Transite* Ducts.

The light weight of Transite Conduit and Korduct permits hauling a substantial footage of duct per truck. Handling is fast, too, because the asbestos-cement composition of Transite Ducts makes them strong and tough. The longer length of each duct . . . 10 feet . . . reduces the number of joints in the completed line. And joints are quickly made with the Transite Tapered Coupling that is engineered to stay tight in service.

For the full story of how Transite Ducts can reduce your cableway costs, write Johns-Manville, Box 60, New York 16, New York.

4 OTHER REASONS WHY TRANSITE DUCTS DO A BETTER JOB AT LESS COST:

1. Corrosion-Resistant. Transite, being made of inorganic asbestos and cement, resists corrosion and is immune to electrolysis.

2. Permanently Smooth Bore. Transite makes long cable pulls easy. Danger of damage to cables is also minimized.

3. Incombustible. Transite will not burn nor contribute to formation of smoke, gases, or fumes . . . confines burn-outs and protects adjacent cables permanently.

4. Higher Thermal Conductivity. Cables run cooler in Transite, reducing I^2R losses, increasing current capacity and prolonging insulation life.

Easy to Handle: Working in a deep trench, this man finds that the light weight of Transite Ducts helps him work without undue strain.
*Reg. U. S. Pat. Off.

Speeds Installation: Transite Ducts are joined so rapidly that the assembly man can often follow right behind the trencher . . . as shown in this installation.

Speeds Distribution: The light weight of Transite Conduit enables the contractor to haul a large number of ducts per truck and speed distribution on job site.

Cuts Manhole Costs: Concrete will be poured directly around these Transite Ducts to form the manhole wall, a time and material saving made possible by Transite's strength.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville TRANSITE DUCTS

TRANSITE KORDUCT—for installation in concrete

TRANSITE CONDUIT—for exposed work and installation underground without a concrete encasement

What Can You Expect ?

...from your POWER FUSES

Full Range Protection ?

—protection against low current faults as well as high, under all conditions of recovery voltage

Accurate Protection ?

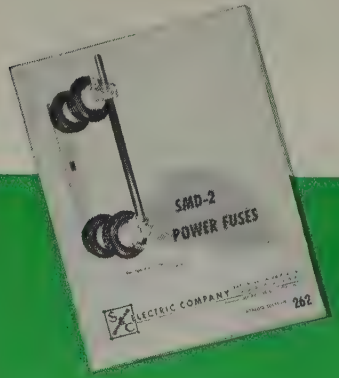
—time-current characteristics which are completely accurate, and which conform rigidly to published curves

Dependable Protection ?

—operating characteristics unchanged by vibration, aging, atmospheric conditions, surges, or fuses blowing on other phases

S&C POWER FUSES have all these characteristics. Their lifelong accuracy permits systems to be planned with close multistep coordination between protective devices . . . brings a **NEW ERA** of system protection . . . **NEW THINKING** about how fuses can be used to better advantage, and **NEW CONCEPTS** of the place for fuses in protecting lines and equipment.

Can we send you further information?



S&C ELECTRIC

4427 RAVENSWOOD AVENUE
CHICAGO 40, ILLINOIS, U. S. A.

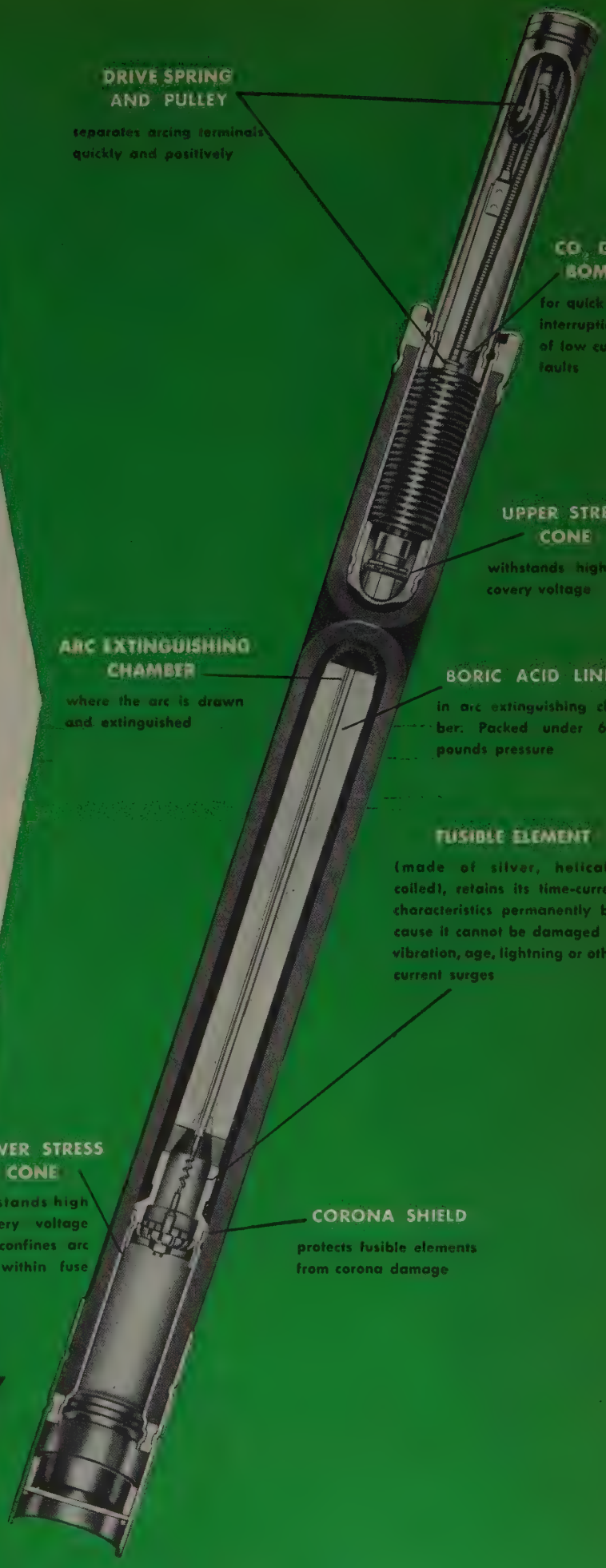
Formerly Schweitzer & Conrad, Inc.

SPECIALISTS IN HIGH-VOLTAGE

S&C FUSES ARE YEARS AHEAD IN DESIGN

The days when baling wire and a fibre tube made an acceptable fuse passed more than a generation ago . . . although many such fuses are still on the market!

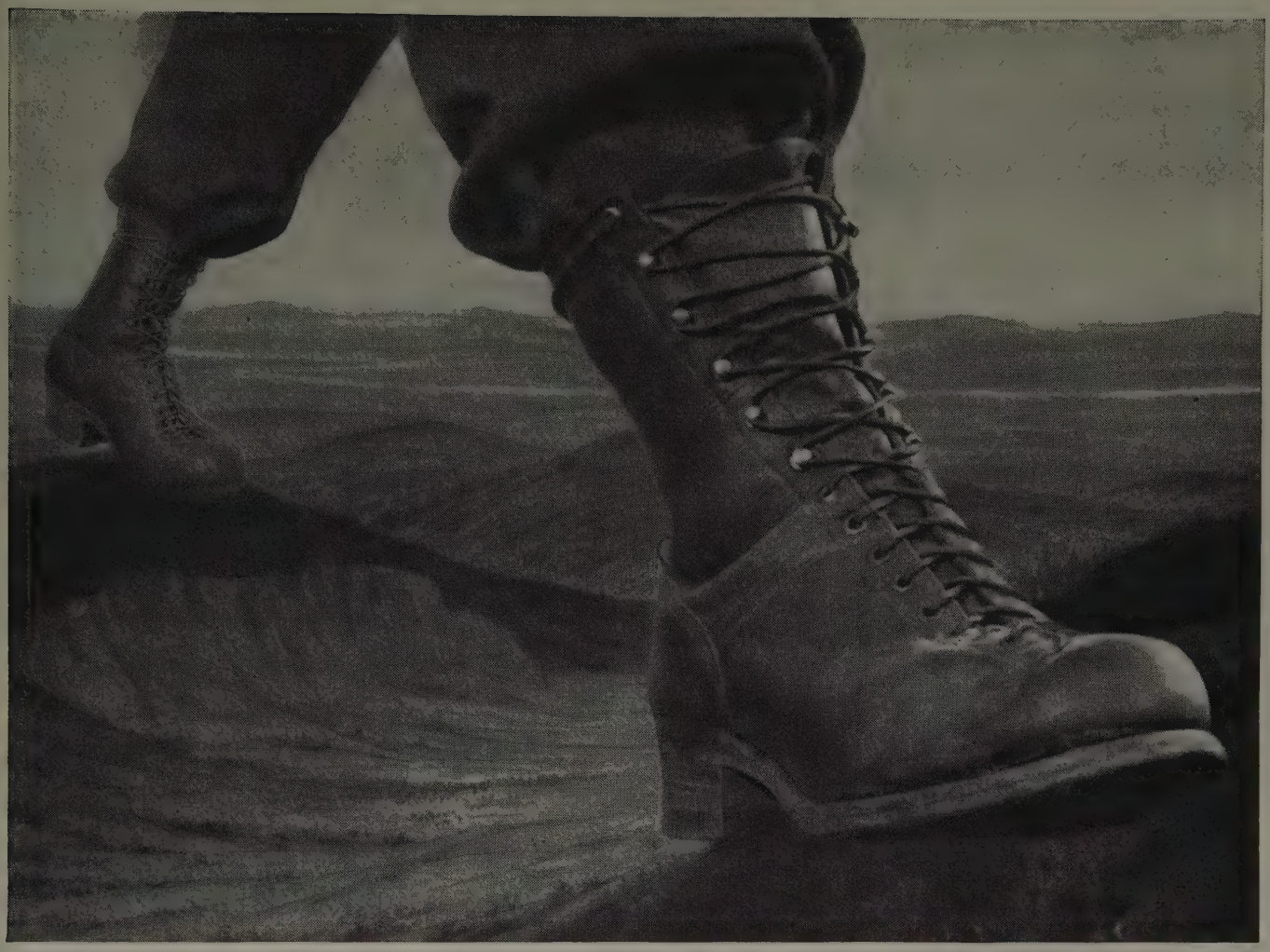
Engineering techniques reflected in S&C Power Fuses mean accuracy and dependability equal or superior to the best-engineered protective devices of other types. Would you like to know more? Write for detailed information.



COMPANY

IN CANADA, Powerlite DEVICES, LIMITED, TORONTO

CIRCUIT INTERRUPTION



SEVEN LEAGUE BOOTS

Giant strides for modern communications! For 500 miles on the El Paso Natural Gas Pipeline Philco microwave averages fifty miles between repeater stations.

5000-7000 mc. frequency range means high-gain, interference free signals. Philco's "Carrier Control"—the exclusive feed-back principle—minimizes carrier distortion. And all Philco systems are designed to provide a thirty-decibel safety margin to combat most severe fading conditions. Only Philco microwave gives sure communications and complete control.

In this rugged, mountainous country, plagued by wind and snow, this entire communications and control system rests on Philco quality equipment. Philco microwave meets Joint Army and Navy specifications wherever applicable and is relied upon by the nation's leading pipelines, railroads, utilities and common carriers.

For reliability, economy and flexibility look to Philco microwave.

For full information write to Department EE

PHILCO Famous for QUALITY the World Over

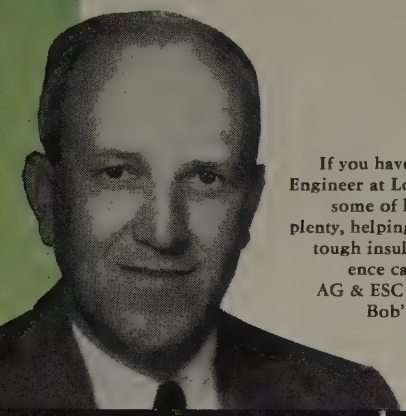
PHILCO CORPORATION

GOVERNMENT & INDUSTRIAL DIVISION · PHILADELPHIA 44, PENNA.

HOW TO TELL

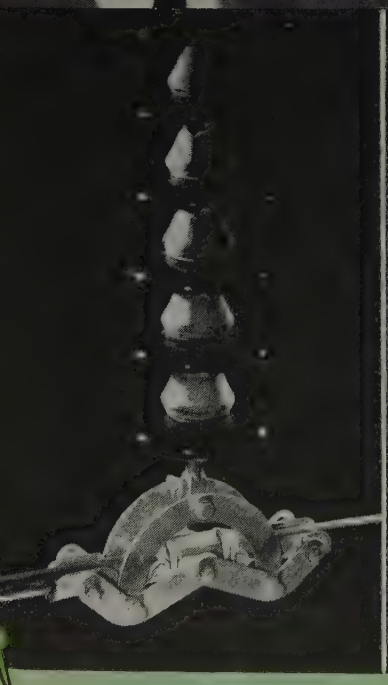
whether you're getting your money's worth . . . in insulators!

"Check your buying experience against this case of American Gas & Electric Service Corporation," suggests Bob McCoy. "You'll know!"



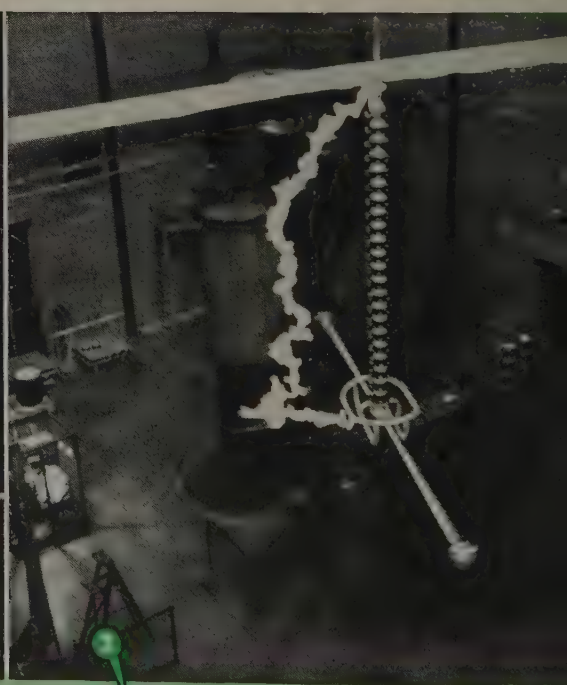
ROBERT L. "BOB" McCOY

If you haven't met Bob McCoy—chief Design Engineer at Locke . . . you probably know about some of his achievements. Bob gets around, plenty, helping Locke customers lick all kinds of tough insulator problems. His 28-year experience came in mighty handy in this case of AG & ESC which Bob describes for you here. Bob's *our* man . . . but remember, when you've got a "toughie," he's *yours* for the asking!



New Suspension Clamp Developed — To support the large, hollow copper conductors used on the TIDD 500 kv experimental line, Locke designed and furnished a radically new articulated suspension clamp, much shorter and lighter than conventional clamps. Overall length of the new Locke clamp is 18 inches long, compared with the 32 inch overall length of a conventional clamp.

New Corona Shield Developed — To lick the corona problem on the TIDD 500 kv transmission line experiment Locke developed a new concept in corona shields. These shields graded the insulator strings and suppressed corona on the lower, highly stressed units. They also enveloped the suspension clamp, thus removing it from the high voltage field and suppressing corona on any part of the clamp itself.



Valuable New Data was revealed by extensive flashover tests conducted in the Fred M. Locke High Voltage Laboratory on varied suspension strings. These flashover tests were made with the insulators supported in a specially developed test rig to simulate true electrical conditions. As a result, important data was developed which helped establish the proper number of insulators to use per string.

Report on
GUIDING PRINCIPLES for DIELECTRIC TESTS

(Published for comment and criticism)

The service record of electric equipment depends largely upon the performance of its insulation, and it has long been the practice to test new insulation at a voltage appreciably greater than its rated operating voltage. Dielectric test voltages should be chosen to result in good operating performance and satisfactory life. The purpose of this report (AIEE No. 51, September, 1949) therefore, is (1) to present a survey of the overvoltages encountered in service, (2) to review existing test values and practices in present standards, (3) to propose guiding principles or the selection of dielectric test values, and (4) to investigate other types of testing to determine their latent usefulness and the desirability of standardization.

✦ ✦ ✦

Proposed Standard for
AUTOMATIC CIRCUIT RECLOSERS for DISTRIBUTION SYSTEMS

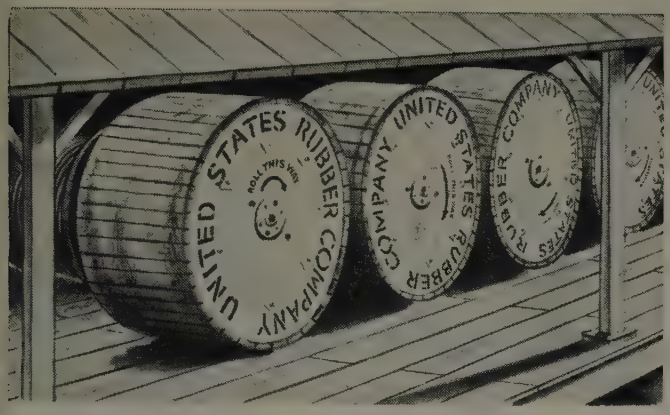
(Proposed for one year trial use)

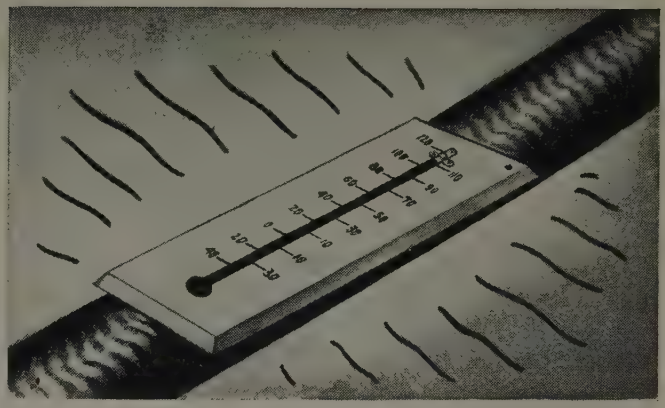
This standard (AIEE No. 50, September, 1949) applies to all single or multipole a-c automatic circuit reclosers rated from 1,500 to 15,000 volts. The work of preparing this standard was carried out by the Working Group on Automatic Circuit Reclosers under the Circuit Breaker Subcommittee of the AIEE Committee on Switchgear.

There is no charge for these publications. Orders should be sent to:

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
33 West 39th Street
New York 18, N. Y. 6-53

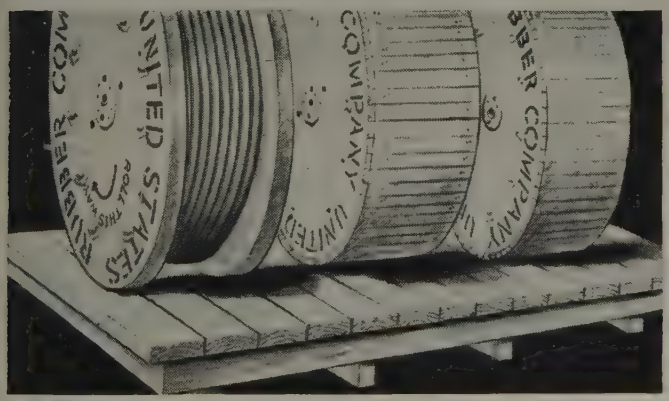
How to prolong the life of wire and cable by proper storage

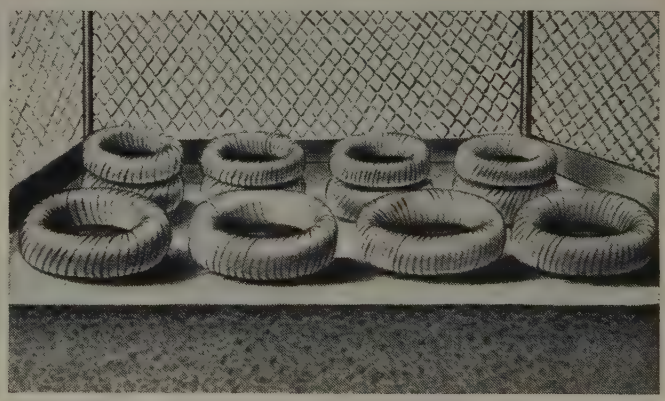




1 **Protect cables from the weather.** Moisture is especially injurious to fibrous coverings. When stored out-of-doors, if they become wet and then freeze, they will be weakened and the saturant will flake off. In humid weather, mold growth is accelerated, weakening the covering and making it easier to damage the cable during installation. (Rubber and thermoplastic insulated and jacketed cables may be stored under moderately humid conditions.) The larger sizes of fibrous covered and rubber jacketed cables and all lead-sheathed rubber insulated cables must be stored on reels which must be properly lagged—or the cable must be otherwise suitably protected against mechanical damage. Reels can be stored out-of-doors if the cable is protected against sun and weather, and the ends are properly sealed.

2 **Don't expose wires and cables to extremes of temperature.** Chemical reactions occur at a higher rate at high temperatures than low. The greatest deterioration of low-voltage cables is due to chemical changes, oxidation or internal changes in the compound itself. Never store reels in the boiler room unless you use a fan to blow hot air away from the wires and cables. It's best to store cables at room temperatures indoors out of direct sunlight. Rubber insulated cables may be stored and handled without damage at the lowest temperatures ordinarily encountered, but thermoplastic synthetic insulated cables should not be handled at temperatures below –10 C. (14 F.)





3 **Reels should be kept off the ground,** so that moisture will not harm the cables, reel flanges and lagging. Sound reels are easier to handle and there is less chance of injury to the cable as it is removed from the reel.

4 **Coils should be stored one layer deep on the floor or shelves,** with the axis either horizontal or vertical. To save space, they may be stacked, but not more than 5 coils in height—otherwise there is harmful pressure on the insulation. Don't remove brown paper or box that protects against dust and light until used.

5 **Rubber insulated fibrous covered, rubber jacketed or lead-sheathed cables in storage** should never be bent to a diameter less than I.P.C.E.A. recommended diameters. Never let coils or reels drop more than a few inches. Always roll a reel in the direction indicated by the arrow on the flange. When rolling an unlagged reel, put planks under the flanges to avoid pressure on the cable. Coils, reels and spools should always be rotated when wire and cable is removed to avoid twisting the cable.

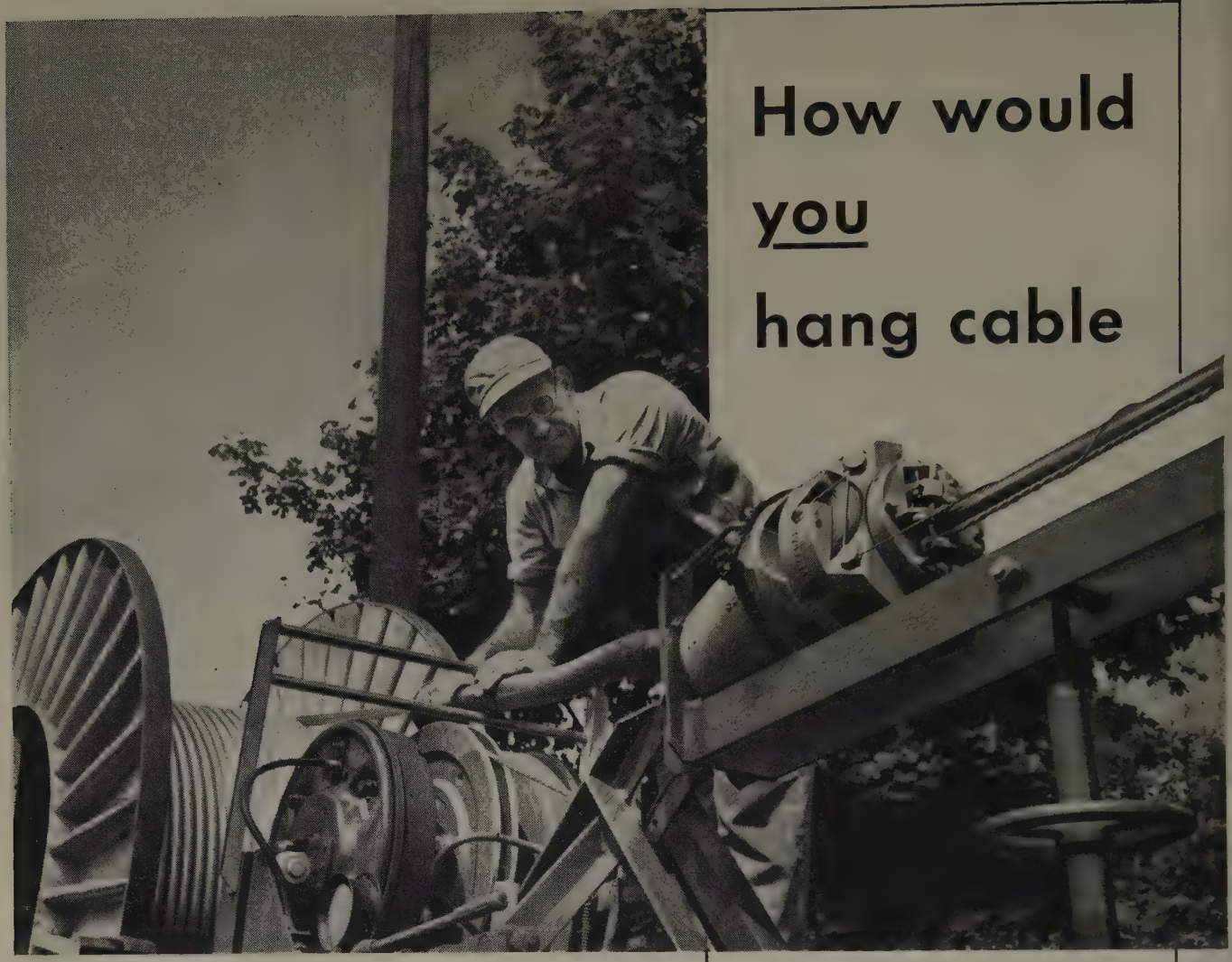
FREE REPRINTS OF THIS PAGE ARE AVAILABLE. WRITE TO ADDRESS BELOW.

UNITED STATES RUBBER COMPANY

U.S.RUBBER
SERVING THROUGH SCIENCE

Electrical Wire and Cable Department

ROCKEFELLER CENTER • NEW YORK 20, NEW YORK



How would you hang cable ...by the mile?

Cable lasher appears to right of workman. As the cable and supporting strand feed through, the machine rotates, binding them together with steel lashing wire. Meanwhile, a winch hauls the lashed cable into position.

It is a job your telephone company faces every day. Thousands of miles of cable go up each year—all secured to steel strand running from pole to pole. The best way to secure cable is to *lash* it to the strand with a spiral binding of wire.

One way to do this is to raise cable and strand separately, then lash them together by a rotating machine pulled along by workmen on the ground. This produces a strong, tight support for the cable. But each pole has to be climbed as many as four times. So Bell Laboratories engineers devised an easier way.

Now, lashing can be done *on the ground* so that cable, strand and lashing wire may be pulled into position as a complete assembly. Usually workmen need make only two trips up each pole.

For telephone users, the new way means that cable can be installed faster, while costs are kept down. It shows again how work at Bell Telephone Laboratories improves each part of your telephone system.

Bell Telephone Laboratories

IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES CAREERS FOR CREATIVE MEN IN MECHANICAL ENGINEERING

What kind of wire do YOU want?

You want manufacturers wire to be uniform in grade, strength and analysis . . . free from harmful imperfections . . . meeting specifications exactly. And that's the kind of wire we've been turning out for over a hundred years. Today we can offer you over 400 different types of American Manufacturers Wire, of every size, shape, finish, and metallurgical characteristic . . . and of *consistently* high quality. All this helps to simplify your fabrication job.

Here's another way we can help you. Our staff of trained metallurgists and engineers know wire-application problems inside-out. They've assisted thousands of manufacturers in finding the most suitable wire for a specific job . . . in cutting costs and improving products. And these men are at your service, ready to go to work on your problems too.

If you want a type of wire that we don't regularly produce, you can depend on our modern plant facilities to draw a special wire that will fit your needs exactly. Call our nearest sales office for further information.

If you make it of wire... make it of the best!

U·S·S AMERICAN MANUFACTURERS WIRE

AMERICAN MANUFACTURERS WIRE

AMERFINE—*High-quality fine wire.*

AMERSPRING—*music steel spring wire.*

AMERLOY—*alloy heading wire.*

AMERTEMP—*heavy-duty oil-tempered wire.*

AMERHEAD—*uniform heading wire.*

AMERSTITCH—*extra-tough metal stitching wire.*

USS TRADE MARK

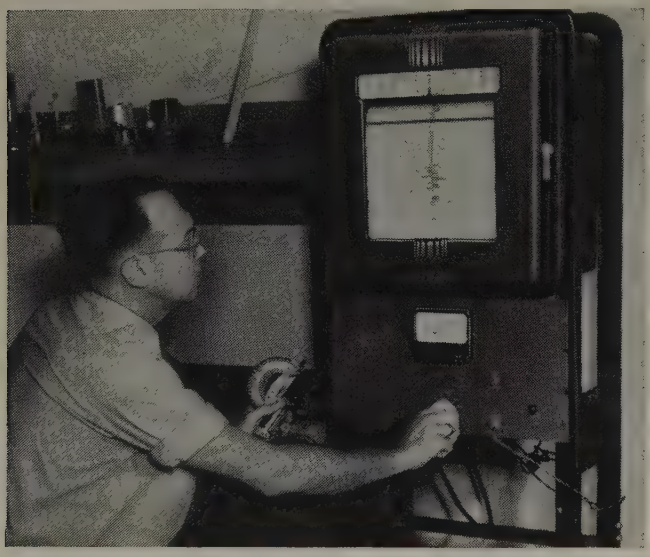
AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION, GENERAL OFFICES: CLEVELAND, OHIO

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS

TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

As a Direct-Reading Instrument *The extreme sensitivity of the d-c amplifier is utilized to check plasticizer insulation resistance values in the megamegohm range.*



As a Recorder Preamplifier *The rack-mounted amplifier above is being used to increase the sensitivity of a recorder in running special tests of switches.*

As a Null Detector *The d-c Amplifier is being used above for factory checking and calibration of instruments.*

L&N Low Level d-c Amplifiers are

Triple Purpose... for Triple Service

● In response to the constant demand for versatility in precision instruments, these d-c Indicating Amplifiers combine the functions of three useful instruments in one:

1. A Direct-Reading Instrument that is always ready to use . . . never any readjusting of zero, either initially or during a series of readings. Simply select the range in which you want to work by turning scale-multiplier knob.

2. A Recorder Preamplifier — Values measured by Stabilized d-c Amplifiers can be recorded directly on Speedomax recorders.

3. A Null Detector more sensitive than most reflecting galvanometers, yet with full scale response time of only 2 to 3 seconds. These instruments are unaffected by vibration; leveling is not necessary. At the turn of a range knob, a wide choice of sensitivities can be obtained without external shunts. A non-linear response characteristic is also available for easy balancing.

These amplifiers are suitable for handling low level measurements with thermocouples, strain gages, bolometers—bridge and potentiometer circuits—ionization, leakage and phototube currents—almost any measurement of extremely small direct current or voltage.

Self-contained, the unit can either be used "as is" or removed from case and mounted on a 19″ relay rack.

For details, including complete specifications, send for Folder EM9-51(1). Write our nearest office, or 4962 Stenton Ave., Phila. 44, Penna.

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Reliable Operation and Constant Timing ... from Mechanically Stored Energy

115- to 230-kv 3-cycle

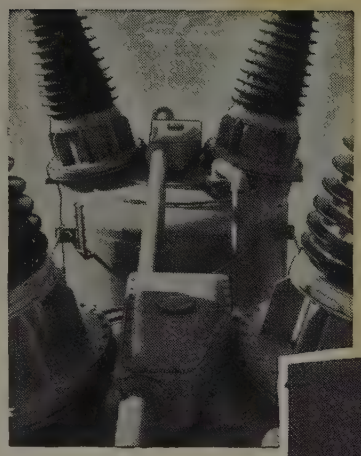
(Also other styles, 7.5 kv and up)

PACIFIC ELECTRIC Type RHE

HIGH-SPEED RECLOSING

CIRCUIT BREAKERS

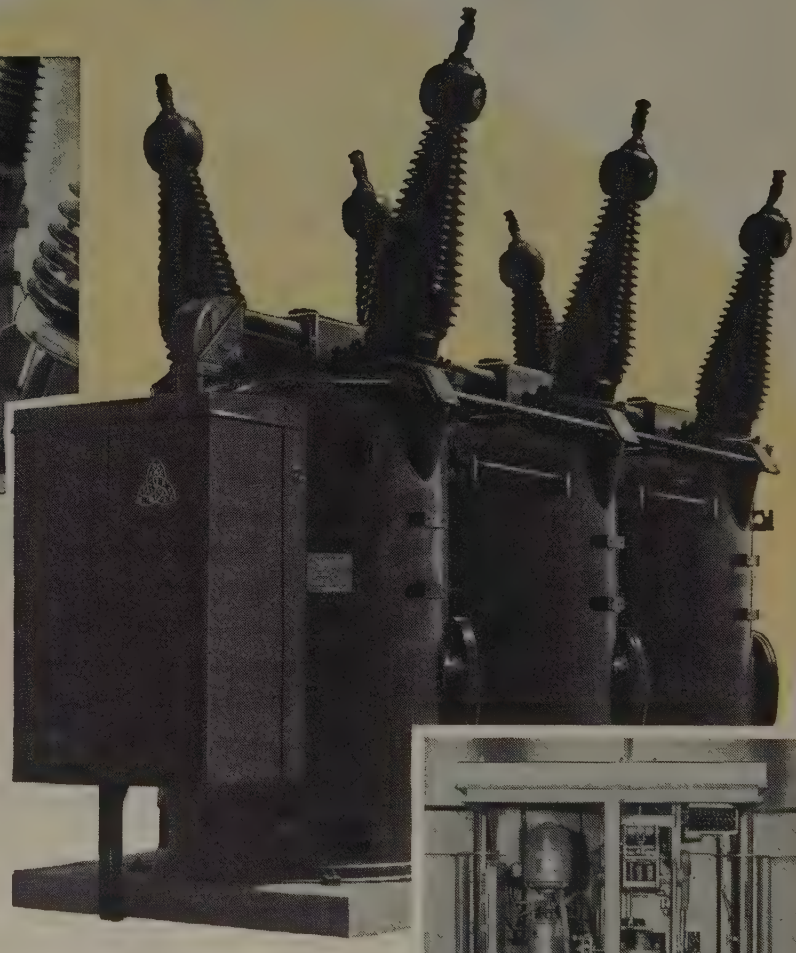
to 10,000,000 Interrupting kva at 161 or 230 kv

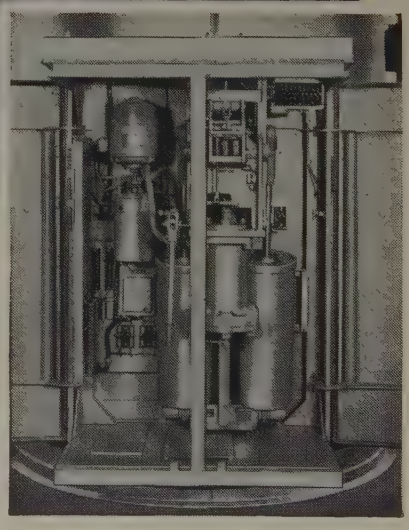


RIGHT: View of Tank Tops, looking toward Tank No. 1, showing housings for opening springs and tube containing pull rod.

CENTER: Type RHE in TEXAS (138 kv).

FAR RIGHT: Interior of Mechanism Cabinet, showing both closing-spring barrels and motor-operated oil-hydraulic jack for spring compression.





THE MOTOR-Compressed operating springs of the PACIFIC Type RHE oil circuit breaker stand ready for action for years, if necessary, without anything meanwhile having to move or operate.

Directly connected to the crank arm of the blade unit in each tank is a set of external opening springs. In the end-mounted mechanism cabinet are the closing springs which act upon the pole units through a pull rod that is compensated for unequal stretch in its sections. Simultaneous operation is thereby assured at all poles.

Energy is stored in the closing springs by means of a motor-operated oil-hydraulic jack. Oil is under pressure only during the ten-second interval required for compression of the springs.

These features insure reliability of operation as well as constant closing time under all conditions . . . of special benefit when synchronizing.

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Are Easy to Double-End

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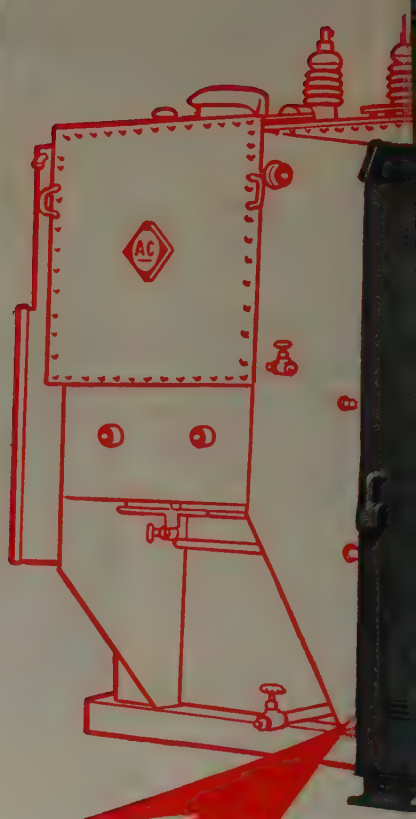


WHEN LOAD GROWTH demands additional power, or when you want the added reliability of two transformers, the Allis-Chalmers Unit Substations you install today will be easy to double-end.

Your line crew will find all mechanical and electrical connections easy to make . . . the transformer throat and switchgear bus easy to align. That's because sufficient mechanical flexibility is built into the throat to permit realistic tolerances in concrete base construction.

Design Aids Quick Field Assembly

Pre-drilled bus extensions are accessible and flexible enough to be consistent with throat construction. There are no compound-filled joints requiring melting, chipping, cracking, or scraping. Just apply no-corona tape and insulating tape to finish the job.

Double-ending is easy also in terms of system operation. When planned from the initial installation, double-ending can be accomplished with no interruption in power service to your customers. Even on substations not planned initially for double-ending, the job can be done with minimum outage.

Because Allis-Chalmers Unit Substations are designed to grow with your system, they are a convenient answer to the growing distribution problem . . . to the ever-increasing demand for power and yet more power. They are simple to specify, neat and modern in appearance, and easy to expand.

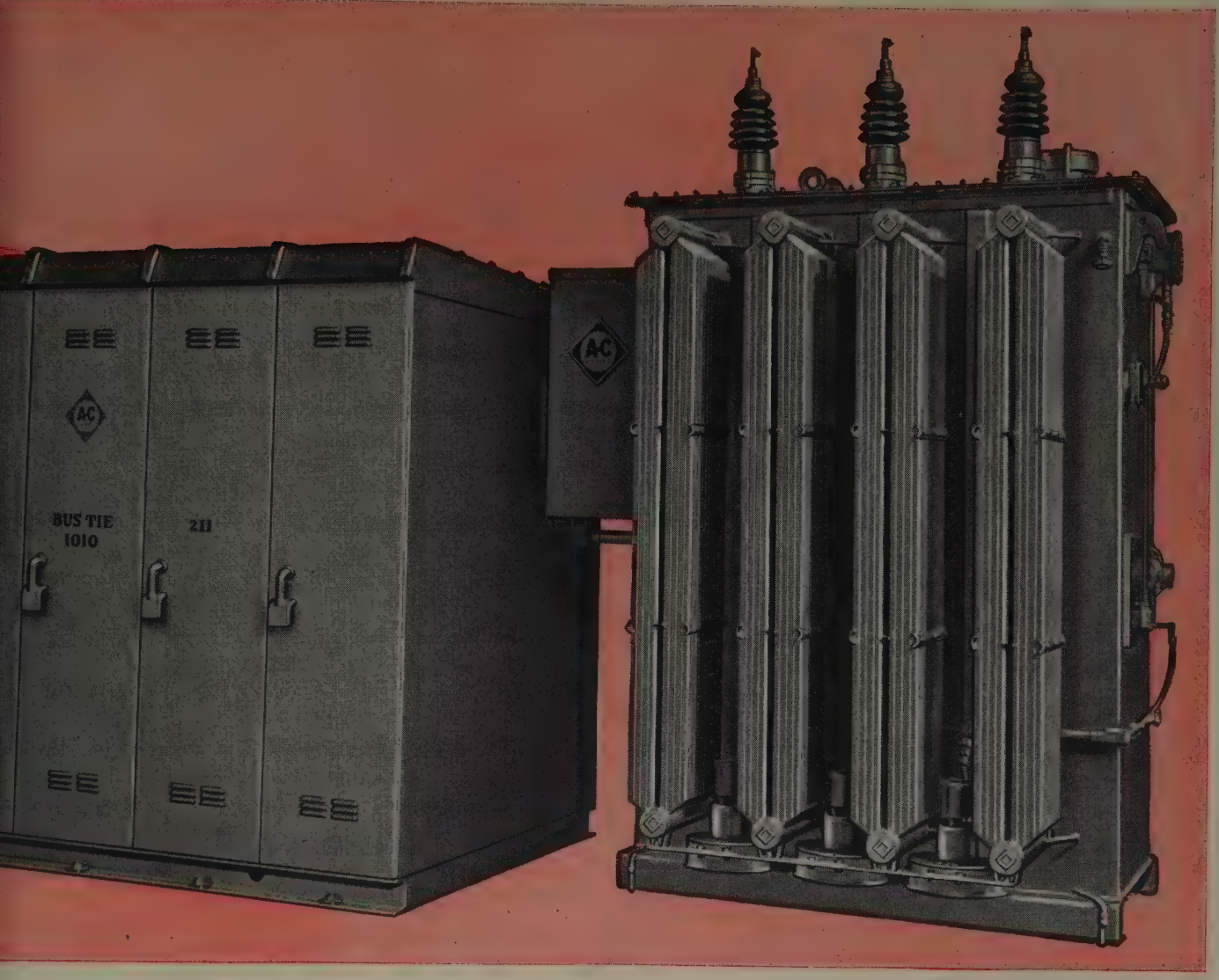
You Save These Five Ways:

(1) Original equipment cost is low; (2) compact construction reduces space requirements and real estate costs; (3) pre-wired unit design speeds installation; (4) maintenance is quick and economical because of improved accessibility; and (5) you purchase only the equipment you need *now*, deferring additional expenses until load growth demands the expenditure.

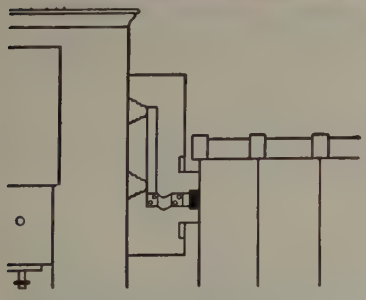
For the full story on what Allis-Chalmers Unit Substations can mean in your distribution system, call your nearby A-C representative, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-3729

ALLIS-

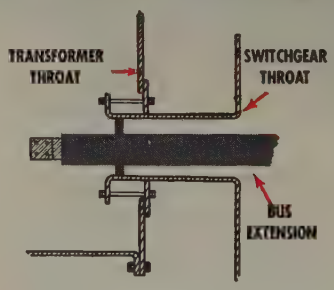


Here's Why It's Easy to Double-End MCS's



1 THE THROAT OPENINGS of all substation transformers, regardless of rating, are the same height as switchgear throat opening. This standardized throat location permits easy addition of a new transformer to the switchgear end of an installed Allis-Chalmers Unit Substation . . . simplifies and speeds field assembly.

2 FEEDER UNITS are jig built so that each feeder cubicle is exactly like every other one. Bus extension openings, control wiring openings . . . even small screw holes . . . are pre-cut in jigs. This careful, uniform construction makes addition of a main breaker easy... assures easy alignment of the new transformer.



3 MECHANICAL AND ELECTRICAL connections are easy to make. Bus connectors and transformer throat are flexible enough to compensate for minor irregularities in concrete surfaces. Silver-plated, pre-drilled bus extensions are easy to bolt together. No-corona tape and insulating tape finish the joint.

CHALMERS

AC ALLIS-CHALMERS

DOW CORNING SILICONES make motors last longer

COURTESY LAKEY FOUNDRY AND MACHINE COMPANY, MUSKEGON, MICHIGAN.

Saves $4500 in rewind costs; outlasts Class A 36 to 1

Engineers at the Lakey Foundry and Machine Company installed a 5-foot induced draft fan at the top of their core oven stack. It exhausted volatiles from the oven so effectively that a resinous deposit built up on the fan blades. This overload, combined with ambient temperatures in the range of 350°F, limited the life of the Class A insulated 7½ hp TEFC motor driving the fan to a month or less.

Life for the motor was further complicated by occasional flash fires that burned off the resinous deposit and melted the aluminum blades. And the cost of getting the motor out of the stack was greater than the rewind costs.

So, the motor was rewound three years ago with Class H insulation made with Dow Corning Silicones. New bearings lubricated with Dow Corning 44 Silicone grease were installed, and the motor was hoisted back into the stack. It has been operating steadily ever since, in spite of all obstacles including 4 stack fires. Savings in rewind costs alone amount to over $4500 at a conservative $125 per failure.

LUBRICATE HIGH TEMPERATURE BEARINGS WITH DOW CORNING 44 GREASE

In open or single shielded bearings designed for high temperature operation, Dow Corning 44 has many times the life expectancy of conventional greases. It gives life-time lubrication in permanently sealed cartridge-type bearings.

That kind of performance in installations all over the country proves that Class H Insulation has 10 to 100 times the life expectancy of the next best class of insulating materials. It can also be used to increase the output of certain motors by as much as 50%.

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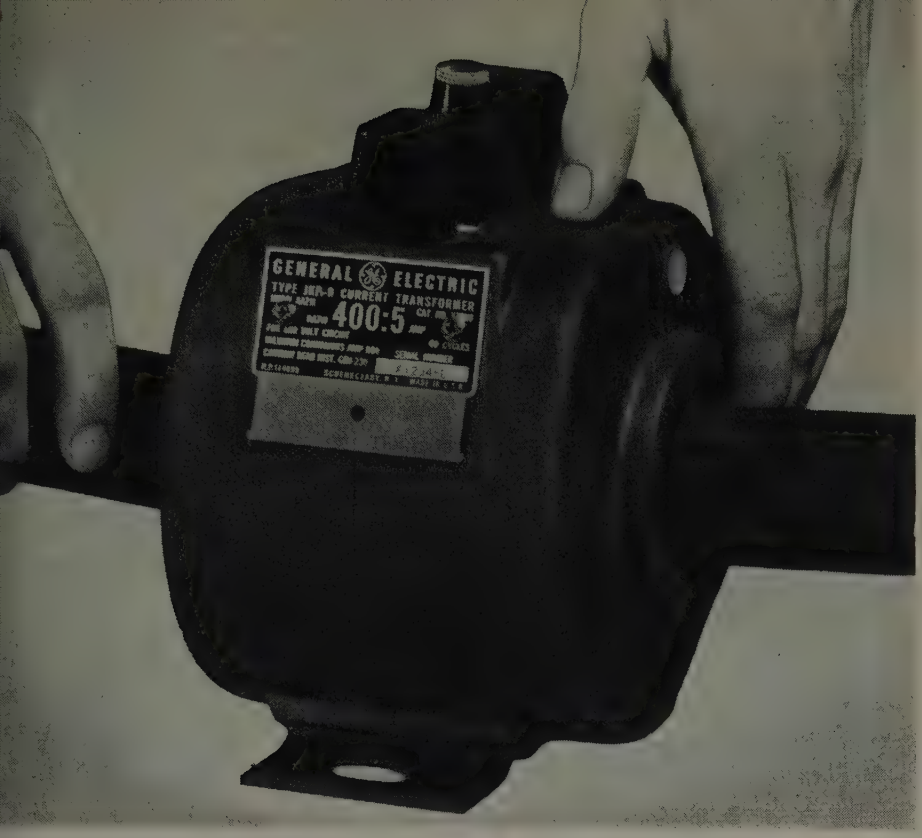

BUTYL-MOLDED, OPEN-WINDOW DESIGN JKP-0 indoor-outdoor versatility. Cut your stock and inventory costs with JKP-0 indoor and outdoor 600-volt applications.

4 in 1

NEW G-E CURRENT TRANSFORMER REPLACES 4 STANDARD MODELS

An outstanding advantage of the Type JKP-0, 600-volt butyl-molded current transformer is its versatility —it easily replaces 4 different types. Here are four ways the JKP-0 saves you money:

1. STOCKING COSTS REDUCED. Standardizing on the JKP-0 cuts costs by reducing stock requirements, simplifying ordering.

2. MAINTENANCE IS REDUCED. JKP-0 transformers will not corrode, breakage is reduced, no painting is needed—JKP-0 is butyl-molded.

3. INSTALLATION COSTS CUT. The JKP-0 does not require elaborate arrangements of crossarms, hanger connections, etc.—and the amount of wiring is reduced.

4. LOWER INITIAL COST. This versatile transformer sells for less than most of the conventional types it replaces.

Write or call your nearest G-E Apparatus Sales Office, or authorized agent or distributor. Ask for Bulletin GEA-5874. General Electric Company, Schenectady 5, New York. 604-38

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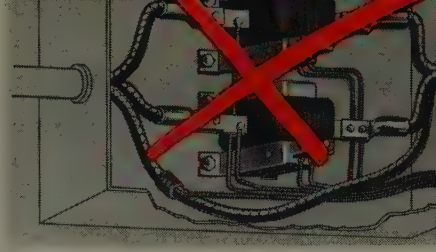
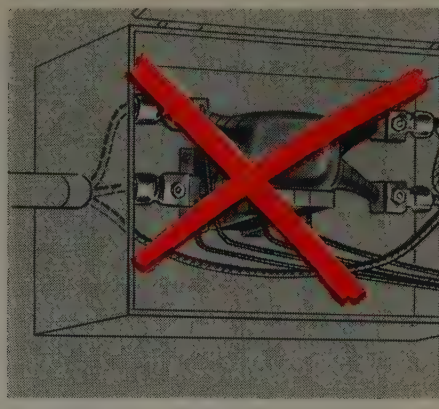
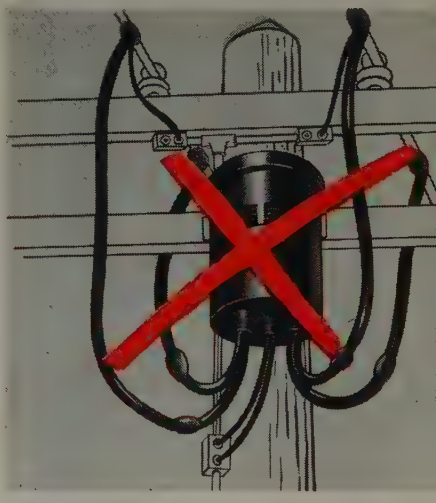


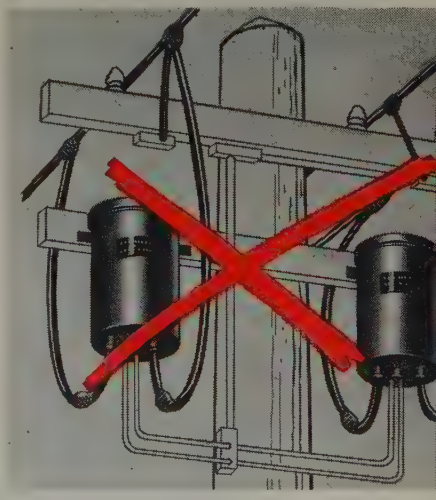
REPLACING INDOOR JL-1 (or newer JKR-0) with the JKP-0 means simplified wiring, fewer connectors—cut costs!



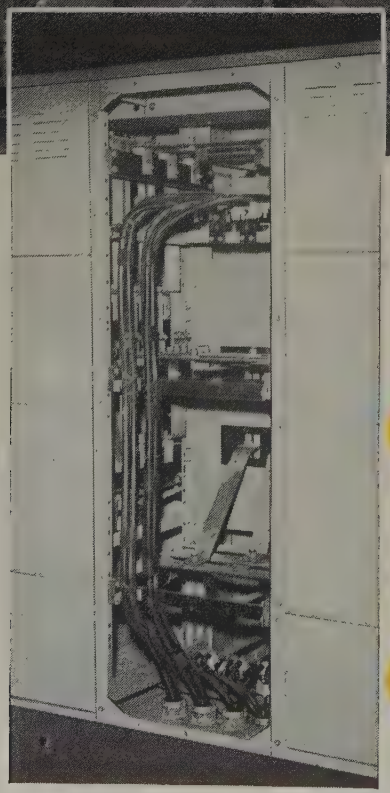
CARRY ONE MODEL in stock instead of four! Above: JKR-1, another transformer easily replaced by the new JKP-0.



FOR OUTDOOR JOBS the JKP-0 eliminates costly crossarms and connectors demanded by conventional Type JKB-1.

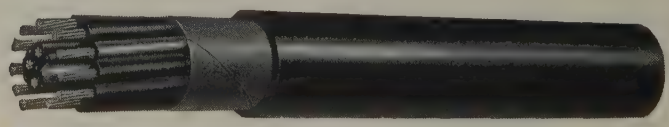


ANOTHER OPPORTUNITY to standardize is realized when butyl-molded JKP-0 replaces JKB-2 outdoor current transformer.

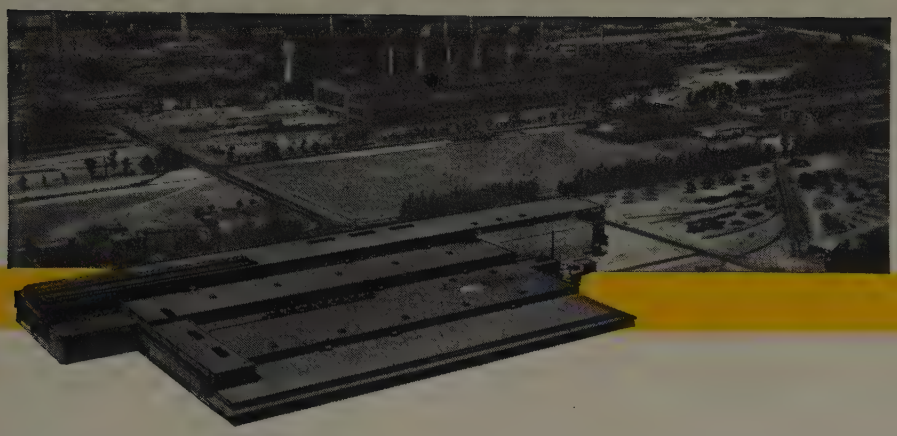


Outdoor connections at switch yard. Note manually prepared terminals.

The 600 volt cable for motor connections and single conductor control cable was RoMarine-RoPrene, style RR-D. All sizes from No. 12 to 1000 CM style RR-D were used for this service.



Multi-conductor control cable in this installation is RoLene (polyethylene) insulated and Rome Synthinol sheathed, described by Rome Cable specification CT-2.



Recently built Kaiser Steel Tin Plate Mill (left foreground), Fontana, California. Capacity is 200,000 tons of tin plate per year.

Electrical Contractor:
Kaiser Engineers, Inc.

ow Kaiser Steel licked 3 tough cable problems all at once

In selecting power cables for 6.9 KV circuits at its new Fontana Tin Plate Mill, Kaiser Steel Corporation faced three knotty problems:

First, the hazard of acid and alkali corrosion was severe.

Second, the threat of electrolytic action was more than a possibility.

Third, termination and splicing costs were important factors.

Kaiser's choice for this service fell to single conductor, 500,000 CM Rome RoZone-RoPrene shielded power cable, insulated for 9 KV. Two sets were installed to connect the main substation with two 6,900 volt busses in the tin mill proper. Total connected load to the busses was 19,000 HP of M-G motors and 14,250 KVA of transformers.

Why RoZone-RoPrene

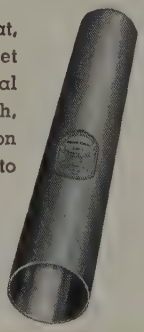
RoZone insulated, RoPrene sheathed cables offer maximum protection against acids, alkalies, oils, greases, moisture, heat, sunlight, and flame. They are non-metallic sheathed and require no lead sheaths. Their RoZone (premium quality oil base) insulation provides exceptional resistance to corona action and ozone cutting.

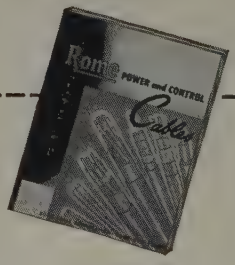
Simple manual terminations eliminate the need for potheads. Standard splicing kits only are needed; no costly wiped joints. And the smooth surface of the RoPrene (Neoprene compound) sheath makes for easy working and pulling through conduits and junction boxes.

HELPFUL INFORMATION—Whether your electrical requirements involve special cable designs to meet severe service conditions or simple home wiring, consider the advantages Rome products offer from the standpoint of price and quality. For information that you may find immediately useful, send for the *Rome Power and Control Cable Catalog* illustrated below.

500,000 CM, single conductor shielded, RoZone-RoPrene power cable, rated at 9 KV.

To give wires and cables added protection against heat, moisture, corrosion and abrasion, several thousand feet are encased in Rome • EMT. This is a superior electrical metallic tubing, electrically welded for extra strength, with an electrogalvanized exterior surface for protection against corrosion and a mirror-smooth interior surface to prevent cable injury.





You'll get a wealth of helpful information from the Rome Power and Control Cable Catalog. It contains 65 pages of illustrated information, specification and test data on all Rome power and control cables and on famous Rome insulations. Mail the coupon for your copy today.

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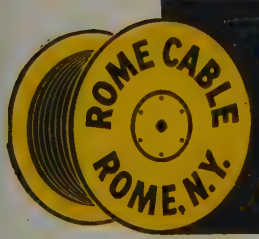

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5. SYNCHRO, O.D. 1.437", 14.4 V and 26 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
6. SERVO MOTOR Mk 7, O.D. 1.437", 115 V, 400 Cycles
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14. SYNCHRO, Size 15, O.D. 1.437", 26 V and 115 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
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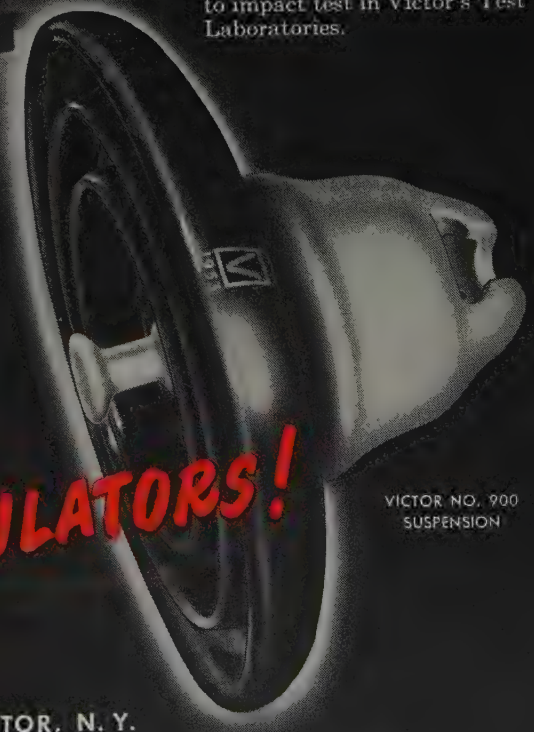

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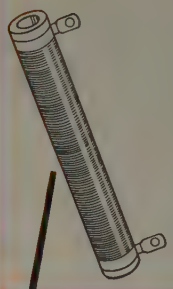
EVEN, UNIFORM WINDING

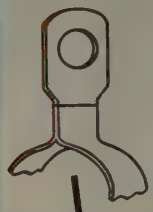


The unsurpassed uniformity of the resistance winding prevents "hot spots" and resultant failures. This uniformity is *permanent* — locked in by vitreous enamel.

VITREOUS ENAMEL COVERING

Acts as both heat conductor and electrical insulator. Holds the winding rigidly in place, and protects it against mechanical damage, moisture, and fumes.

TINNED TERMINALS

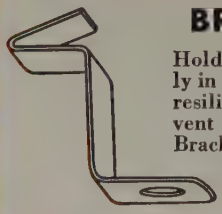


Terminal lugs are tin-dipped for ease in soldering to connecting wires. Resistance wire is welded or brazed to the lug, assuring perfect electrical connection.

STRONG CERAMIC CORE

The high-strength ceramic tube provides a sturdy insulating base for the resistance winding. It is unaffected by cold, heat, fumes, or high humidity.

RESILIENT MOUNTING BRACKETS



Hold resistor firmly in place, yet have resilience to prevent shock damage. Brackets are simple to attach; can be easily removed by a slight upward pressure at the base.

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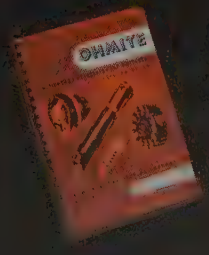
4803 Flournoy Street, Chicago 44, Ill.



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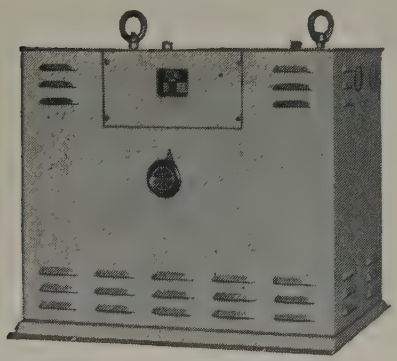
Ask us to help you work out your requirements.



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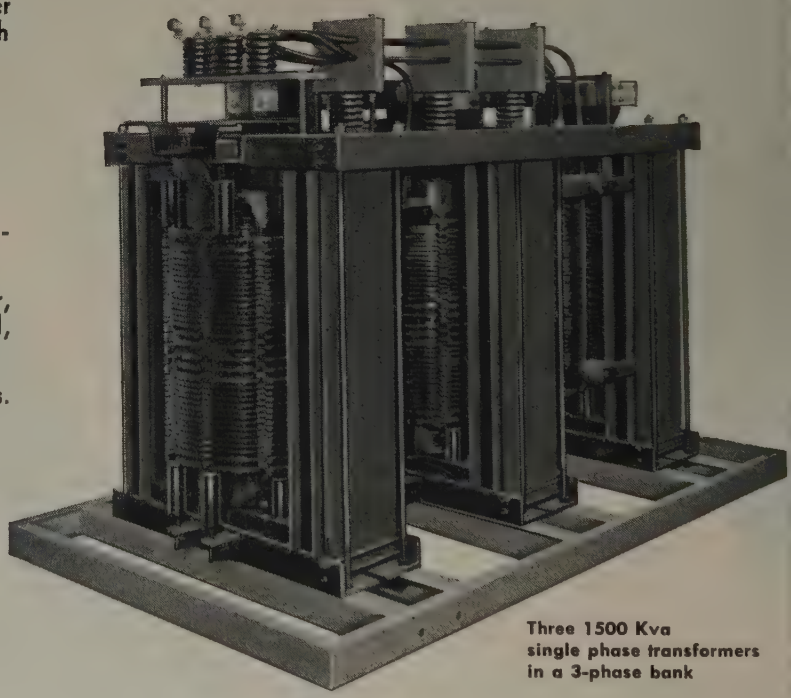
with potentiometer control



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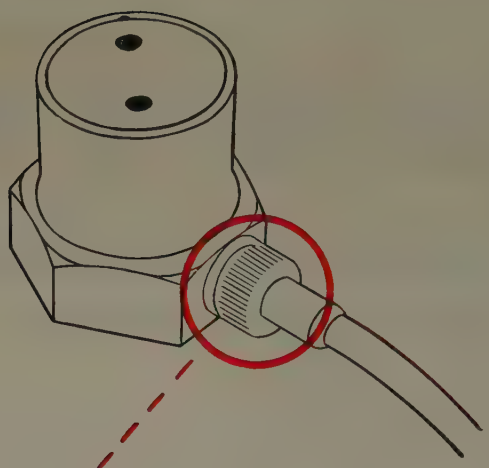

Du Pont TEFLON* provides excellent dielectric properties...

Coaxial connectors and cable made by Microdot Division, Felts Corporation, S. Pasadena, Calif.

...heat resistance and strength in new miniature parts

The demand for micro-miniature components in scale with miniaturized circuit designs has created an insulating problem. Miniature circuits often develop high heat and carry an increased electrical load that can result in failure of these tiny components.

The Felts Corporation faced such a problem with its miniature coaxial connector. They needed a material for the connector and primary wire insulation that had good dielectric properties and a wide resistance to heat, chemicals and corrosion. It also had to be moisture-resistant and strong.

After testing many materials, they chose Du Pont "Teflon" tetrafluoroethylene resin. "Teflon" is an excellent insulator. It has a dielectric constant of 2.0 and a loss factor of 0.0005. Its power factor is less than 0.05% even at frequencies as high as 30,000 megacycles. And these dielectric properties are unaffected by temperatures from -80°F. to 500°F. Du Pont "Teflon" is inert to all chemicals except molten alkali metals and fluorine. It is tough and durable—will not crack or arc. "Teflon" has zero water absorption and helps reduce self-generated noise at high termination impedances.

Du Pont "Teflon" serves many uses in electrical equipment—stand-off and feed-thru insulator terminals, insulation for wire, cables and motor windings, and other parts where high temperatures, dielectric strength and durability are required. Perhaps "Teflon" can help you improve or develop a product. For full information, write: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 216T, Du Pont Bldg., Wilmington 98, Delaware.

*REG. U. S. PAT. OFF.

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BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY
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OKONITE'S 75TH ANNIVERSARY

Here's what

PROOF OF DEPENDABILITY

The real proof of dependability is in service records, for no claim or specification can be better judged than by the passage of time. The best example of Okonite's dependability is that Okonite cable, which was already in use before the electric light was invented, is in increasing demand today

LONG SERVICE LIFE. An Okonite cable, after 36 years of service in the old Hotel Gibson, was reinstalled in the new hotel erected on the site.

Here's what

PROOF OF VERSATILITY

Small low voltage cables or large high voltage transmission systems are all within the scope of Okonite manufacturing experience. Whether underwater, underground or aerial, Okonite has developed wires and cables that operate continually under the severest tests that such installations can impose.

UNDERGROUND. Okolite-Okoprene underground cables are designed to be buried directly in the ground.

Here's what

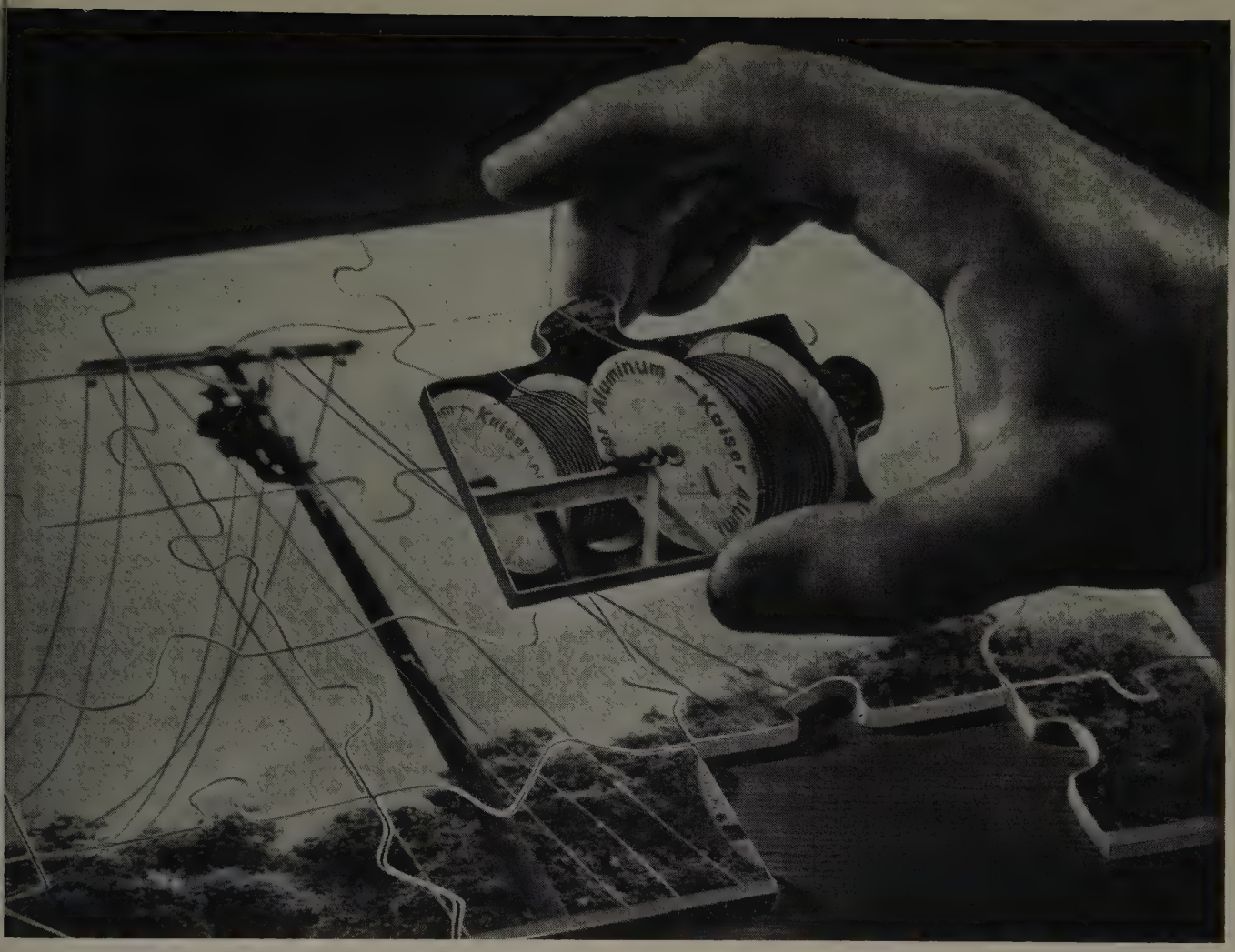
PROOF OF CUSTOMER SATISFACTION

Wherever electricity is transmitted, whether in large blocks of power or for sensitive low voltage control, Okonite has been specified in orders and re-orders. The wide-spread use of Okonite wires and cables is proof of Okonite's acceptance as a leader in the field.

Utilities, railroads and industry recognize the fact that there is no substitute for experience . . . and that the Okonite symbol is the guarantee of quality. The Okonite Company, Passaic, New Jersey.

UTILITIES. Utility companies use Okonite cables for such varied purposes as control cable, transformer and generator leads, and transmission lines.

OKONITE OKONITE SINCE 1878 ***insulated cables***



How your Kaiser Aluminum conductor distributor fits into your picture

UNDER any market conditions, the *wide range of services* offered by your Kaiser Aluminum electrical conductor distributor makes him an important part of your picture.

He has available a large line of Kaiser Aluminum conductor—including the largest range of sizes and constructions of covered aluminum wire in the industry. This distributor availability gives you the benefit of *fast delivery* to help reduce your inventory.

He learns *your* problems, suggests solutions based on his specialized knowledge and years of experience handling problems *like* yours. And he makes available to you top-notch engineering services of his own and of Kaiser Aluminum.

He keeps himself—and you—up-to-date on new developments. And he gives your order friendly, personal attention, whether the job is large or small.

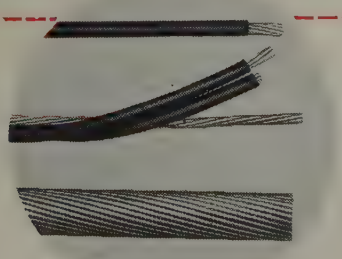
Get in touch with your nearby Kaiser Aluminum electrical conductor distributor *now*. Refer to the list below and your local telephone directory.

Kaiser Aluminum offices located in principal cities. Kaiser Aluminum & Chemical Sales, Inc., Oakland 12, California.

Kaiser Aluminum

setting the pace—in growth, quality and service

Neoprene and Polyethylene Covered Conductor, Solid and Stranded
Self-Supporting Triplex Cable • ACSR • All Aluminum Conductor



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CABLE-GRAM
THE ULTIMATE PROOF OF QUALITY IS IN THE CONTINUING TEST OF TIME. FOR ALMOST ONE HUNDRED YEARS THE QUALITY OF KERITE INSULATED CABLE HAS BEEN DEMONSTRATED BY LONG DEPENDABLE SERVICE LIFE UNDER THE MOST SEVERE CONDITIONS. KERITE'S ACCEPTANCE IS GREATEST WITH THOSE WHO HAVE USED IT LONGEST.
THE VALUE AND SERVICE LIFE OF A PRODUCT CAN BE NO GREATER THAN THE INTEGRITY AND CRAFTSMANSHIP OF ITS MAKER.
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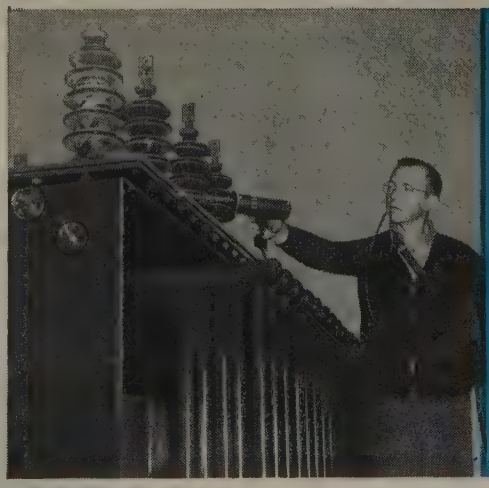
SEALED TANK CONSTRUCTION

means longer-life low maintenance

Tight sealing that prevents "breathing" and the entrance of moisture, prolongs the service life of Uptegraff Transformers. Oxygen and moisture are found to be the principal causes of oil deterioration. All flanges and openings are so effectively sealed, that even the keen perception of the super-sensitive electronic Leak Detector does not find any sign of leakage.

This is only one of many features that give Uptegraff Transformers exceptionally long life expectancy, and reduce maintenance costs.

Uptegraff makes distribution transformers in all commercial ratings, from 3 KVA to 500 KVA, and in a complete series of dry type air-cooled designs, as well as the liquid-filled units.



Every liquid-filled Uptegraff Distribution Transformer is checked by the electronic Leak Detector before shipment. The photograph above shows front and rear views of a single phase, 60-cycle, 26,400-13,100Y/7560 volts, 500 KVA transformer.

R. E. UPTEGRAFF MANUFACTURING COMPANY

Scottdale, Pennsylvania

JOINT AIEE-IRE CONFERENCE ON TELEMETERING AND REMOTE CONTROL

AIEE Special Publication S-54 contains papers and discussions presented at the Conference on Telemetering and Remote Control sponsored by the AIEE and the Institute of Radio Engineers (IRE) and held at the Lafayette Hotel, Long Beach, Calif., August 26–27, 1952.

Four sessions were held during the two days and 17 papers were presented. Subjects covered include both wire and radio telemetering. The first session dealt with papers on telemetering pickups. A paper on "Theory and Design of Vibrating Wire Transducers" describes a relatively new type of telemetering pickup with good stability and high-frequency response.

At the second session, three papers dealing with problems of FM-FM telemetering systems were presented. The session was concluded with a panel discussion on problems of radio telemetering. A brisk discussion from the floor resulted from the panel presentations and is included.

The third session continued the discussion of radio telemetering problems. A paper at this session described some of the problems encountered in telemetering data required for upper atmosphere research.

The final session dealt with wire telemetering. Problems of power systems, telephone systems, and petroleum production operations were discussed in four papers.

Publication S-54 is available at the price of $3.50 to members and nonmembers from:

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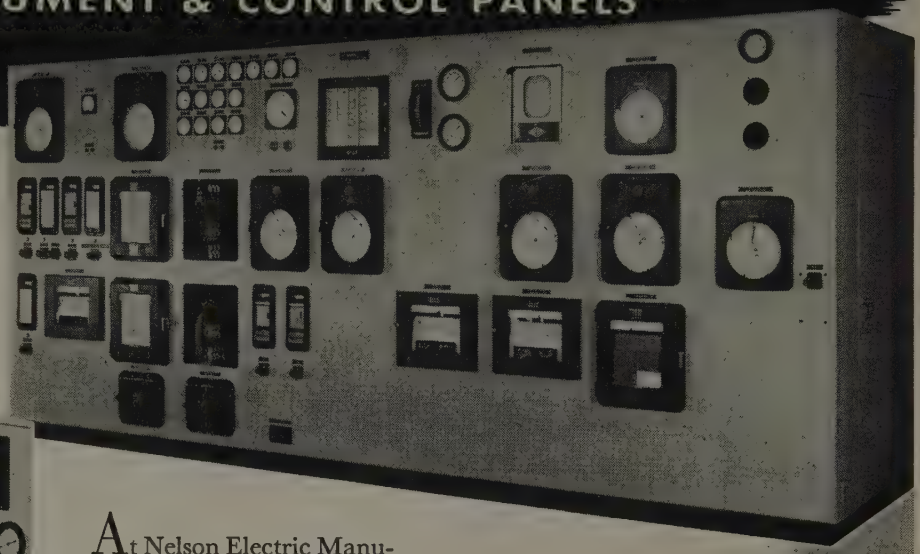
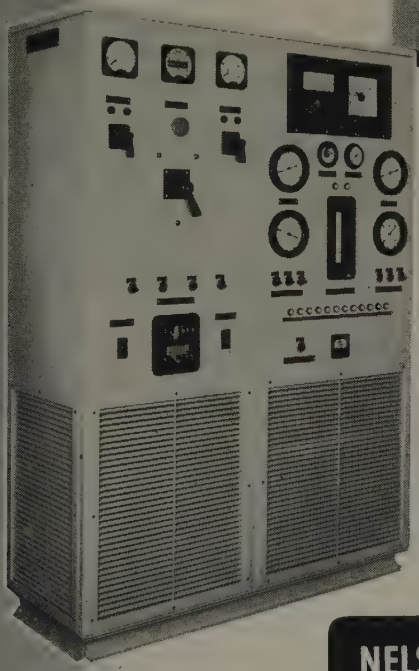
6-53

CUSTOM-BUILT
INSTRUMENT & CONTROL PANELS



▶ Piped and wired instrument and control panel for power plant.

▼ Engine control panel.



At Nelson Electric Manufacturing Company, engineering know-how and manufacturing skill are utilized in producing custom-built instrument and control panels that meet, in every detail, each customer's requirements. We do all of the design work (if you desire), all fabricating, all wiring, all piping and all testing. Let us quote on your requirements.

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TULSA, OKLAHOMA

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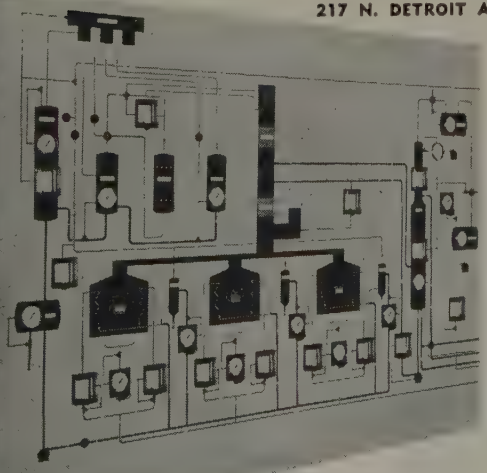
▲ Pressurized piped and wired cubicle for kiln control.



▲ Graphic instrument panel with multi-colored flow lines.

▲ Control panel installed in products pipe line station.

BIBLIOGRAPHY ON POWER CAPACITORS 1925-1950

This Bibliography (S-43) was prepared as an activity of the Capacitor Subcommittee of the AIEE Committee on Transmission and Distribution and is intended to present a consolidated reference to the principal significant literature in the field of capacitor applications to power circuits. Only basic and original material has been presented.

Contents of this new publication include:

(1) LIST OF PERIODICALS

(2) BIBLIOGRAPHY ON POWER CAPACITORS, catalogued into the following divisions:

Capacitor Economics

Capacitors (*their design, construction, operation, and maintenance*)

Capacitor Applications (*miscellaneous, and general, industrial, and utility power factor correction*)

(3) BOOKS AND RELATED BIBLIOGRAPHIES

(4) AUTHOR INDEX

The price is $1.25 (no discounts possible). Copies may be obtained from:

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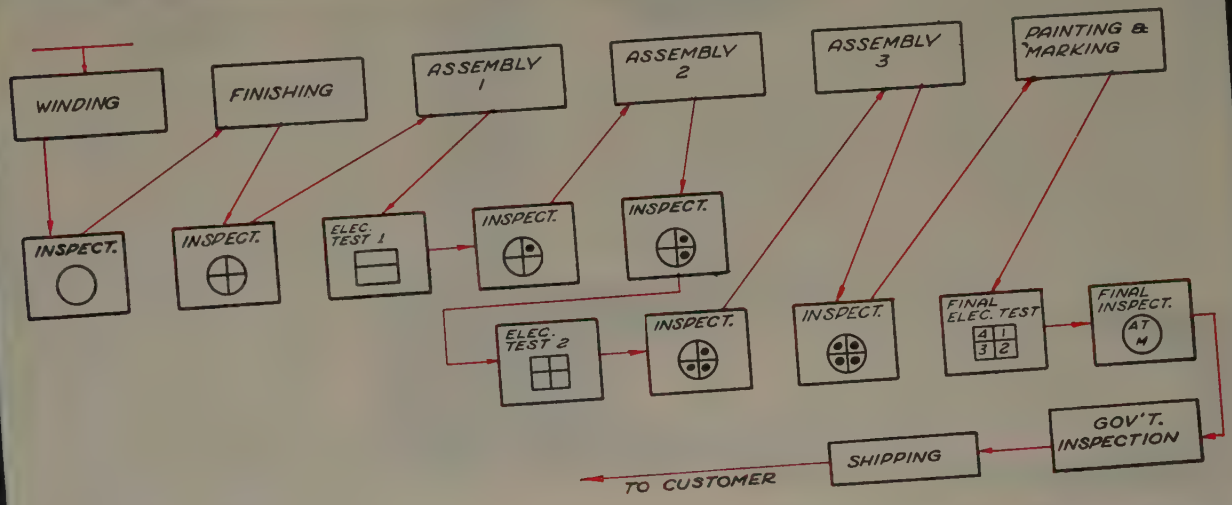
6-53

Quality First

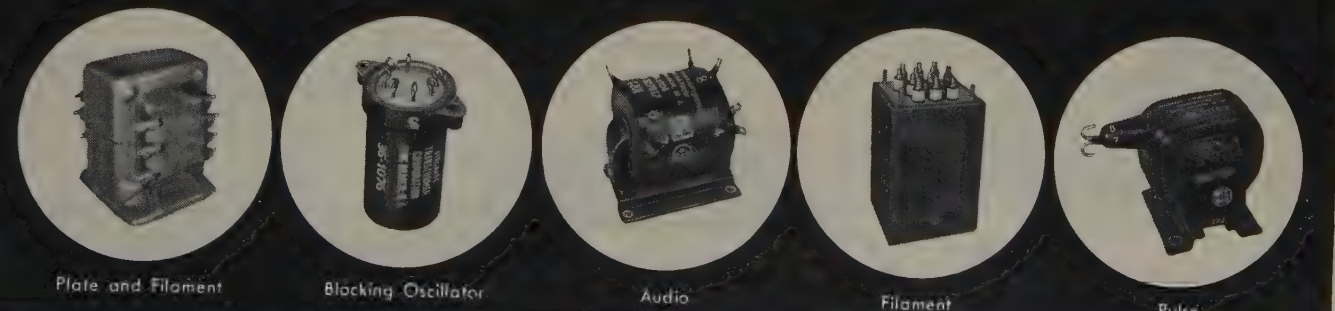
Your Transformer Has To Pass These 10 Inspections



Equipment pictured are samples of the various types of transformers manufactured by Aircraft Transformer Corporation, originators of the famed FORMFLEX

AIRCRAFT TRANSFORMER CORPORATION

MANUFACTURERS OF INDUCTIVE EQUIPMENT • LONG BRANCH, NEW JERSEY. LONG BRANCH 6-6250



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BRITISH COLUMBIA PROJECT
CANADA

Ferranti transformers ordered for this project comprise four 71,000 kVA single-phase generator transformers forming a 213,000 kVA, 13,200/301,000 volt 3-phase bank at KEMANO and three 37,000 kVA, single-phase step-down transformers at KITIMAT, will form a 111,000 kVA, 275,000/13,200 volt, 3-phase bank. The contract was secured against international competition by the Ferranti organisation through Ferranti Electric Ltd., Toronto, Canada.

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are serving all over the map!

Literally thousands of Elliott generators are quietly reeling off the kilowatts, serving in every state of the Union. Types include direct-current, alternating current, horizontal and vertical generators. Elliott "Fabri-Steel" construction used in all present-day Elliott generators, not only provides exceptional rigidity and crack-proof strength, but also facilitates custom-built design to the precise requirements of the individual installation.

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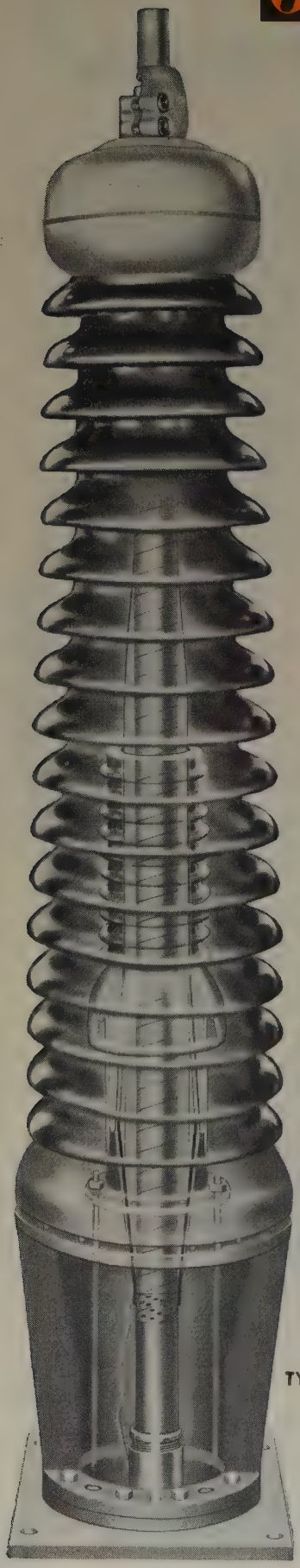
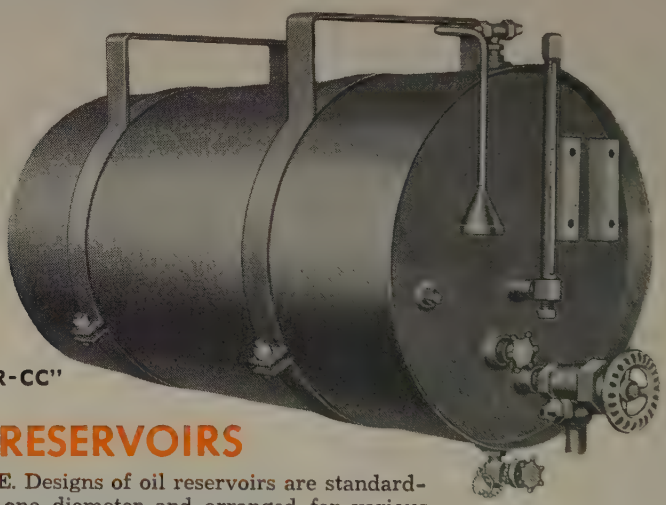


TYPE "ATA"
161 Kv.

CABLE ACCESSORIES, up to 161 Kv., formerly made by General Electric Co. were turned over to G & W on January 1, 1953. Cable manufacturers and users are assured that G & W has the qualified personnel with the necessary engineering and manufacturing experience and production facilities for properly handling this category of equipment. G & W designs of potheads in this class have proved very satisfactory and will be continued. G & W has received the G. E. patents and drawings and is now in production on oil reservoirs, relays, spreader heads, gas cabinets, valves, tapes, oil, gas and compounds, and cable joint material kits. Design details have been revised where desirable to improve the devices—for example, pressure tight housings are now fabricated from sheet or spun metal instead of castings to eliminate possibility of leaks due to porosity.

POTHEADS

Proper treatment of mechanical and electrical stresses permit the simple G & W design shown at the left. In this Type "ATA" pothead, full 200 pound pipe line oil pressure is retained by the relatively small bore porcelain shell. Stress relief cone, supplemented by porcelain stress control tube, makes efficient use of the internal diameter and length of porcelain shell—and reduces the amount of installation labor.



TYPE "R-CC"

OIL RESERVOIRS

The G. E. Designs of oil reservoirs are standardized to one diameter and arranged for various valves, filling fittings and oil level gauges as required. Two styles of interchangeable brackets for ceiling, wall or corner mounting. The three types of reservoirs are available in sizes given below.

TYPE "R-AC"-Oil in tank, gas in sealed unit cells. For feeding oil into joints and potheads on "solid" oil filled cables. Sizes 3, 5, 10 and 15 gals.

TYPE "R-CC"-Oil in cells (manifolded to cable). Oil in tank, vented to atmosphere. Same purpose as "R-AC," but for conditions which permit the use of a gravity feed reservoir. Sizes 3, 5, 10, 15 and 20 gallons.

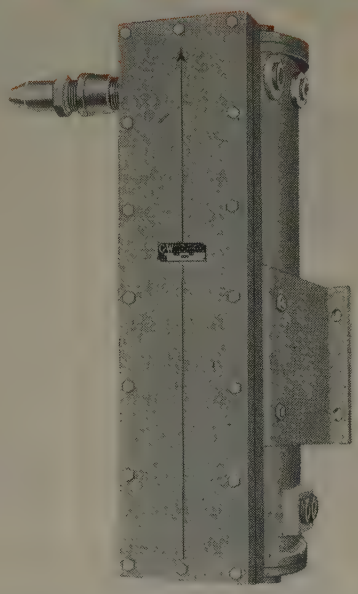
TYPE "R-DC"-Oil in cells (manifolded to cable), gas in tank. Balanced pressure type for feeding oil filled cables where gravity feed is not suitable. Sizes 3, 5, 10, 15, and 20 gallons.

SPREADER HEADS

For use with 3 conductor, shielded, lead covered cables, solid, gas or oil filled paper insulated, which are to be terminated in single conductor potheads. Made in various forms, and sizes, the Type "SH" illustrated is a typical gasketless style.

CABLE ACCESSORIES

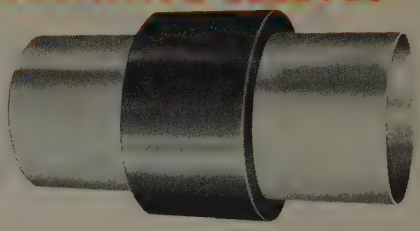
RELAYS



Relays, used in conjunction with alarm devices, give automatic warning of the existence of dangerous minimum or maximum pressure conditions. Simplified and improved functional relays of various designs are available for adaptation to the three types of oil reservoirs for low pressure oil filled cable systems—and for low, medium and high pressure gas filled cables.

The Type "EG" relay illustrated is for use with Type "R-CC" oil reservoir only. This relay has a steel ball float in a vertical brass tube and magnetic linkages which actuate the alarm circuit switches. The protective enclosure is bolted to the front of the "R-CC" reservoir.

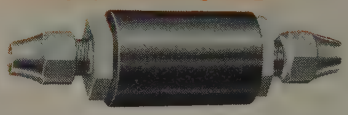
INSULATING SLEEVES



To eliminate circulating sheath currents in large size single conductor cables, insulating sleeves are used in the cable sheath or as joint sleeves to break the continuity of the cable sheath. Sections between insulators are bonded and grounded at one point only. The resultant voltage induced on the sheath is kept within safe limits and the current carrying capacity of the cable is not affected by the sheath losses.

Insulating sleeves are available in the G. E. molded insulation type (illustrated) and in the G & W soldered porcelain type.

PIPE INSULATORS



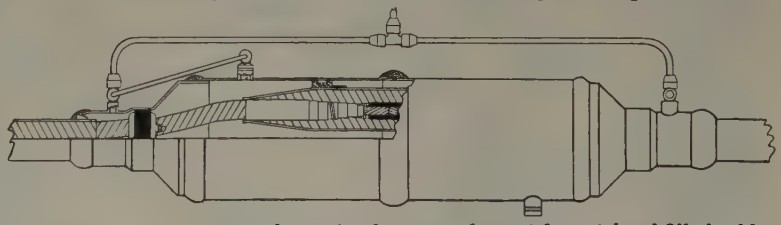
Pipe insulators, Bakelite, with flared fittings for ⅜ o.d. copper tubing, are used to break the electrical continuity between reservoirs and cable joints or potheads.

TAPES, COMPOUNDS and OILS, GAS, CABINETS, VALVES and FITTINGS

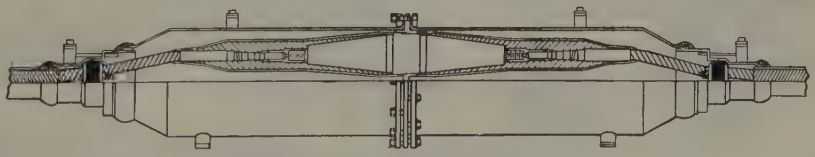
These materials and devices for use in conjunction with oil and gas filled cable terminations and joints are available from G & W for your convenience.

CABLE JOINTS

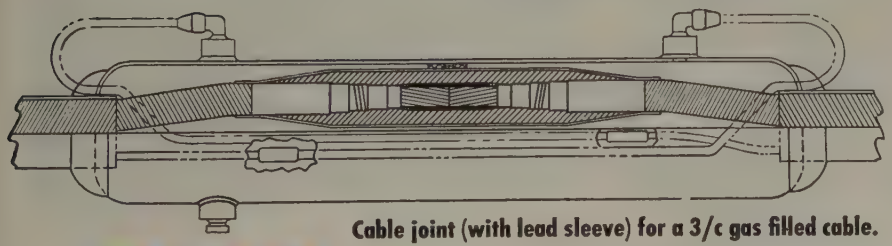
Carefully prepared designs and complete jointing material for all sizes and types of oil and gas filled cables are furnished by G & W. Joints are designed individually for specific cable installations. Simple construction from the standpoint of installation is an important consideration.



Normal joint (with copper sleeves) for a 3/c oil filled cable.



Typical stop joint for a 3/c oil filled cable.



Cable joint (with lead sleeve) for a 3/c gas filled cable.

Your orders and inquiries for oil and gas filled cable accessories received direct or through cable manufacturers will be given our careful attention.

AT 531

G & W ELECTRIC SPECIALTY COMPANY

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STANDARD FOR SWITCHGEAR ASSEMBLIES AND METAL-ENCLOSED BUS (1-52)

AIEE Standard No. 27 (which supersedes No. 27 issued in 1942) covers assemblies of switchgear devices such as switches, interrupting devices, control, metering, protective and regulating equipment with associated interconnections, enclosed bus, and supporting structures.

$0.60; 50 per cent discount to members of the AIEE

AMERICAN STANDARD GRAPHICAL SYMBOLS FOR SINGLE (ONE) LINE ELECTRICAL ENGINEERING DIAGRAMS (9-51)

Sponsored by the AIEE, the American Society of Mechanical Engineers and approved by the American Standards Association, Inc. This new standard, Y32.1.1-1951, contains graphical symbols for single (one) line electrical engineering diagrams. These diagrams indicate, by means of single lines and simplified symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein. It is intended that a single line diagram may be used to show essential components and functions in simplified form. Examples of diagrams and an index to graphical symbols are also included.

$1.40; 50 per cent discount to AIEE members

AMERICAN STANDARD FOR CAPACITOR UNITS (12-51)

AIEE Standard No. 18 and American Standards Association (ASA) No. C55.1 1951 supersedes the C55 issued in 1934. Sponsored by the AIEE and approved by the ASA, the standards in this section apply to shunt and series-connected capacitor units on a-c power transmission and distribution systems at nominal frequencies of 60 cycles or below, for the purpose of modifying the performance of the circuits at normal frequency.

$0.40; 50 per cent discount to AIEE members

The above new standards may be obtained from the Order Department, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, 33 West 39th Street, New York 18, N. Y.

6-53

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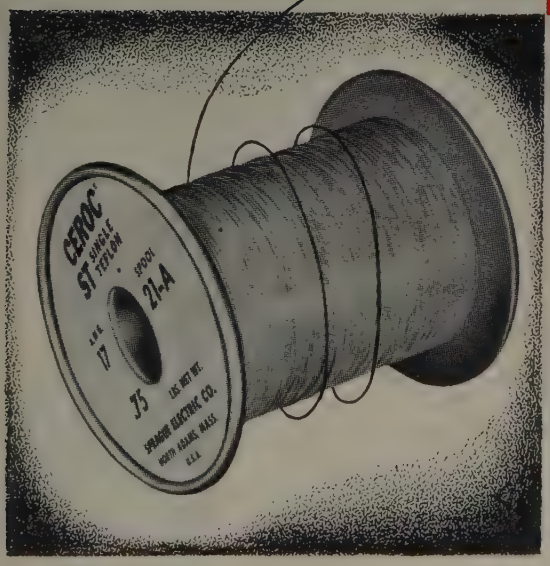
HIGH TEMPERATURE magnet wires

FOR CLASS H+ OPERATION



If your problem is the design of reliable miniaturized electrical equipment, investigate the size and weight savings possible with Ceroc Magnet Wires.

Ceroc Magnet Wires operate at temperatures well above the 180°C limit for Class H insulation, because they have a base insulation of a thin, flexible ceramic material. No other wire uses this patented construction!

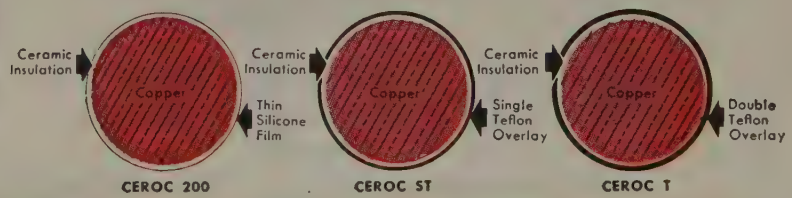
For operation at 250°C, Ceroc ST (Single Teflon) and Ceroc T (Double Teflon) have a tetrafluoroethylene overlay. Both have been used successfully up to 350°C in short-time military applications. Ceroc 200 for 200°C application has a silicone coating on the ceramic to facilitate winding.

Not only does the construction of Ceroc Magnet Wires permit very high current densities, but it also results in better cross-over characteristics in windings than those obtainable with all-plastic insulated wires.

For engineering data on Ceroc Magnet Wires, write on your business letterhead to the Sprague Electric Company, 321 Marshall Street, North Adams, Massachusetts.

Sprague, on request, now will provide you with complete application engineering service and assistance for optimum results in the design and manufacture of components using Ceroc High-Temperature Magnet Wires.

ENLARGED CROSS-SECTIONS OF CEROC MAGNET WIRES



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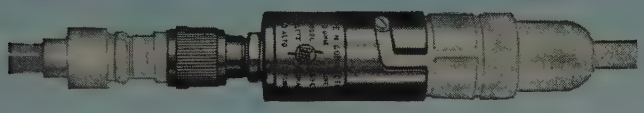

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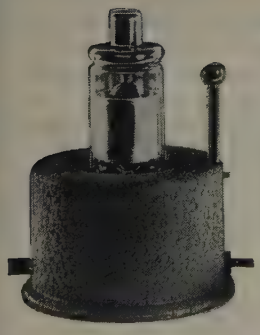

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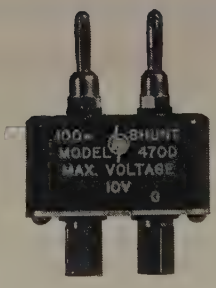

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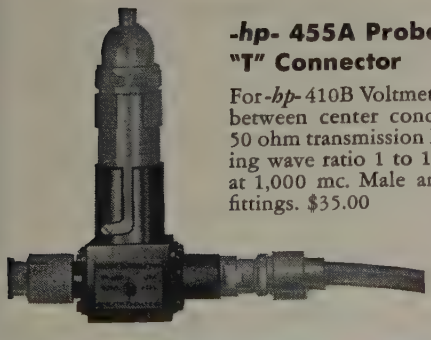

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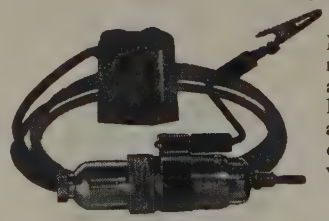

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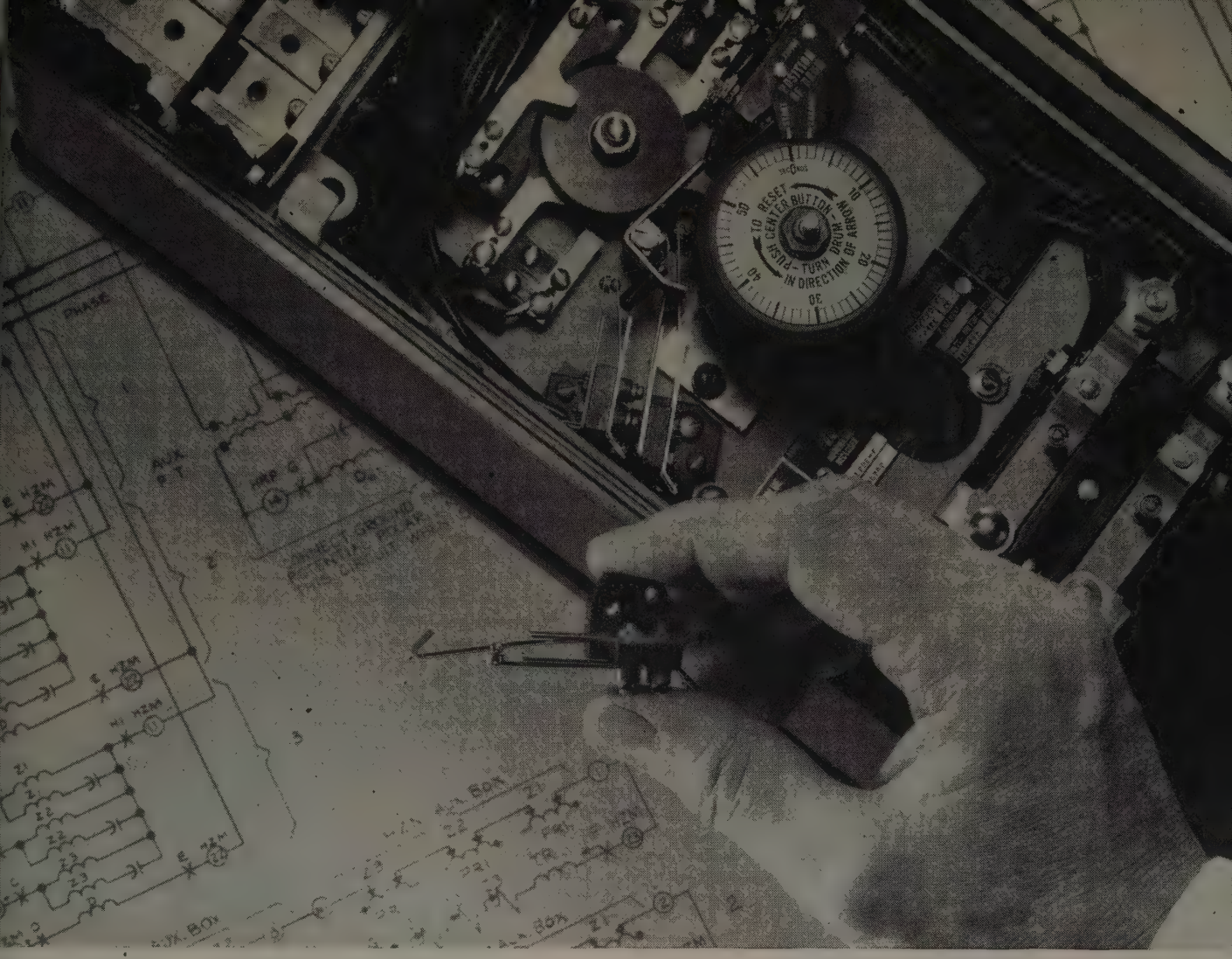

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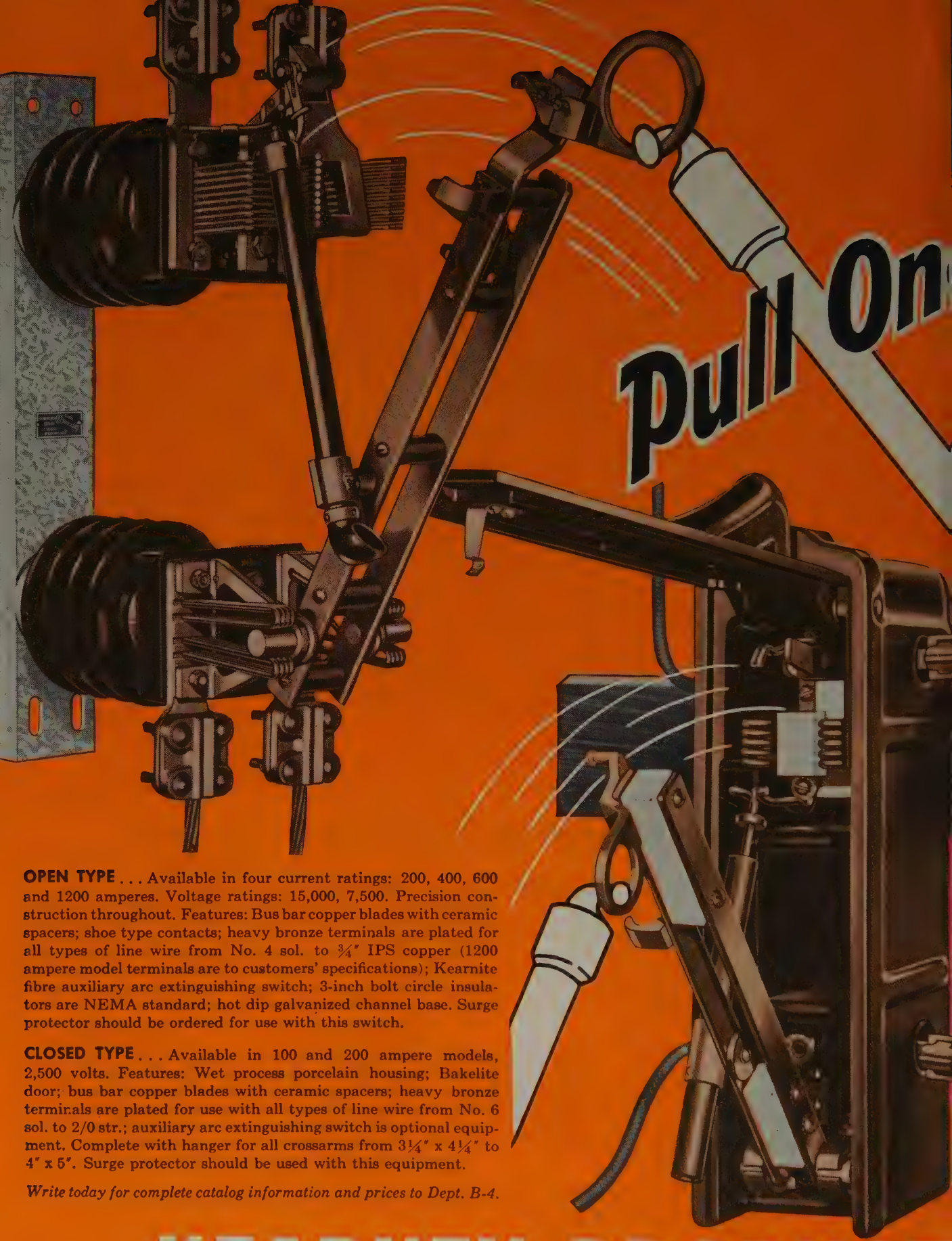

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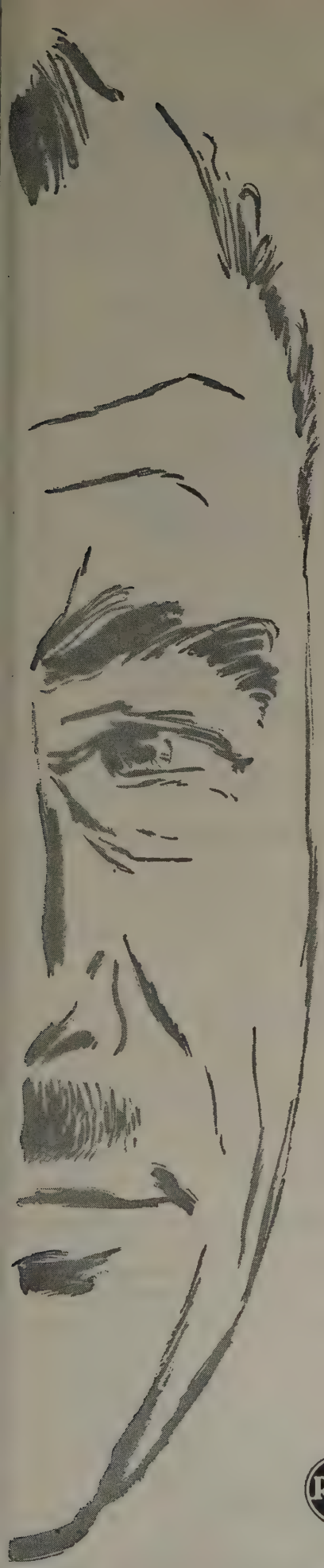

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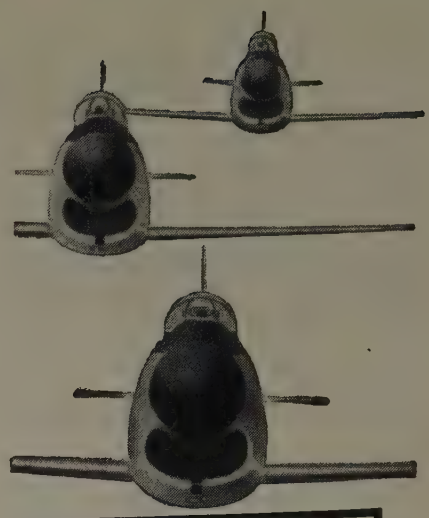

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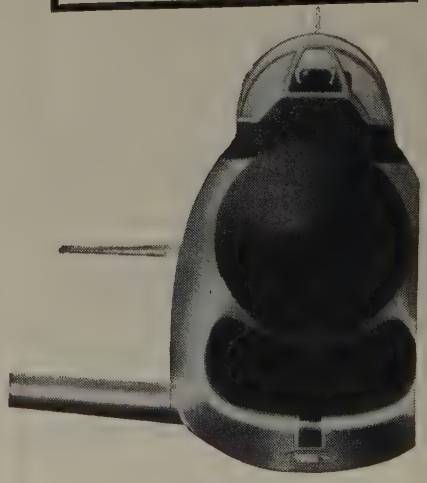

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RATE ENGINEER, 28–35, electrical graduate, with at least three years' public utility experience. Must have knowledge of Spanish for travel assignments in Latin America. Salary, $6000–$8000 a year. Headquarters, New York, N. Y. Y-8224.

ELECTRICAL ENGINEER for expanding organization of established manufacturers' technical representative. Must be able to plan own schedule and assume engineering responsibility for a group of products. Experience in switchgear, unit substations and resistance welding equipment valuable. Salary plus profit sharing. Write giving salary, etc. Location, California. Y-8259.

ELECTRONIC ENGINEER with advanced degree and six to eight years' of applicable experience preferred. Specializing in measurement and calibration. Ability to set up and direct all phases of electronic measurement and calibration required, involving supervision of several specialists. Salary, $6000 a year and up. Company will pay placement fee. Location, East. Y-8348.

ELECTRICAL DISTRIBUTION SUPERINTENDENT for municipal system, with supervisory experience in O.H. and U.G. system construction, operation and maintenance. Electrical engineering graduate preferred but experience and demonstrated ability considered in lieu of degree. Will take charge of operation, maintenance, planning and new construction. Salary open. Location, Louisiana. Y-8357.

ENGINEERS. (a) Industrial Relations Assistant with electric utility experience. Knowledge of Spanish or Portuguese desirable. Some travel to Latin America. Salary, $6000–$8000 a year. Location, New York, N. Y. (b) Technical Writer, young, electrical or mechanical engineering graduate, with editorial experience, to prepare industrial relations material and safety articles. Salary, $5000–$7000 a year. Location, New York, N. Y. Y-8365.

ELECTRICAL OR MECHANICAL ENGINEER for administrative position in engineering department. Must have had work experience in the design of electro-mechanical products and supervisory experience in a small engineering department of an electrical manufacturing plant. Salary, $6000–$10,000 a year. Location, Connecticut. Y-8370.

ELECTRICAL ENGINEER, under 35, with electric utility experience, to assume post of General Electrical Superintendent or to work into this position. Position is with a hydro-electric utility having 40,000 customers and comprises high-voltage transmission, substations, underground and overhead distribution. Salary open. Location, Bolivia. Y-8387.

PHYSICIST OR ELECTRICAL ENGINEERS, graduates, for research and development work on electro-mechanical design. Should have from two years' experience in electro-mechanical equipment. Company will consider an older man, possibly on a part time basis for one position which is a strictly theory job. Salaries from $5000–$7000 a year. Location, Connecticut. Y-8398.

ELECTRICAL ENGINEER, experienced, graduate with electrical engineering degree, 25–35. Will handle problems of electric power generation, distribution and utilization. Will prepare specifications for and recommend selection of electrical equipment such as generators, motors, switch gear, motor starters and electrical instruments. Will design power and lighting systems and prepare load surveys on circuits. Must be familiar with electrolytic theory of corrosion and be capable of conducting electrolysis surveys in large oil refinery to determine sources and amounts of stray currents, their effects, and recommend remedial measures. Will design cathodic protection systems for underground pipe lines, tank bottoms, water cooled product condensers and

coolers. Write giving qualifications in full and state salary requirements. Location, New York Metropolitan Area. Y-8403.

ELECTRONICS ENGINEER, specialist in measurement and calibration. Should have ability to set up and direct all phases of electronic measurement and calibration. Position involves the supervision of several specialists. Should have advanced degree and six to eight years' of applicable experience. Salary open. Location, New Jersey. Y-8465.

SALES AND SERVICE ENGINEERS for manufacturer of high quality magnetic recording equipment for professional sound recording and industrial instrumentation applications. Must be electrical graduate with major in electronics, and at least two years' experience in sales work, field servicing or design. Should have general knowledge of various fields of electronics and industrial endeavors, so as to readily grasp the performance characteristics and capabilities of complex magnetic recording equipment and determining how this equipment can be applied for various industrial or instrumentation uses. (a) Engineers for installation and servicing of data recording equipment. Salary, $5000–$7000 a year. (b) Sales Engineers. Salaries, $7000–$9000 a year. Location, East. Y-8468.

STANDARDS ENGINEER, electrical, mechanical or industrial, with three to five years' experience, preferably in industrial engineering in chemical process industry, for standards program for maintenance, materials and equipment in company manufacturing synthetic textiles. Some travel. Salary, $7000–$7500 a year. Location, South. Y-8470.

SALES ENGINEER, 28–34, with mechanical or electrical engineering training and electrical equipment experience to sell switches, circuit breakers and controls. Salary, $5200–$5720 a year plus commission. Various locations in East and Midwest. Y-8477.

DISTRIBUTION ENGINEER, electrical graduate, no experience necessary, but desirable. Will act as technical assistant to superintendent of municipally-owned electrical, water and sewerage systems. Combination of field and office work and opportunity to obtain broad experience. Systems serving community of about 25,000 population. Starting salary, $4200 a year with increase to $4800 a year in first 12 months. Location, Georgia. Y-8510.

ENGINEERS. (a) Electrical engineer, young, to take charge of operation, maintenance and improvements on new atomic accelerator. Interest in physics desirable. Opportunity to work with group of prominent nuclear physicists. Salary, $4428–$5508 a year. (b) Electrical Engineer, young, for work under senior electrical engineer for one year, then to have engineering responsibility for manufacture, distribution and other electrical engineering, installation and maintenance problems. Will be understudy for a year until present man retires. Salary, to start, $4800 a year. Location, upstate New York. Y-8563.

ENGINEERS. (a) Technical Writer, group leader, electrical or mechanical, to take charge of project in preparing maintenance manuals. Must understand maintenance techniques and large equipment such as heating, ventilating and lighting, etc. Salary, $7500–$8000 a year. (b) Technical Writer to work under supervision, but with above maintenance technique, background and experience. General specifications writing on industrial equipment considered. Salary, $5400 a year. Location, New York, N. Y. Y-8569.

DESIGNER, electrical graduate, over 35, with ten years' or more experience in motor and generator design. Will do designing and assist chief engineer on motor and generator design from 300 to 7000 hp. Must have both a-c and d-c experience. Salary, $9600 a year. Company will pay placement fee. Will also pay moving expenses. Location, Pennsylvania. Y-8571.

TRANSFORMER ENGINEER with minimum of five years' experience in design of small and medium sized transformers up to 250 kva. Any experience with military specifications or in the electronics field very desirable. Salary, $8000–$9000 a year. Location, California. Y-8576.

ELECTRICAL ENGINEER for a construction job, experience in handling an office force of about eight employees, together with a labor force of about 200 electricians. Will take complete charge of all electrical installations and will be in direct contact with the general contractor handling all problems that might arise with them. Salary, about $9100 a year. Duration, 18 months to two years. Location, Louisiana. Y-8581.

INSTRUCTOR with B.S. in physics, electrical or mechanical engineering, to teach physics to engineering students. Salary, $3000–$3600 a year. Location, New York Metropolitan Area. Y-8590.

ENGINEERS. (a) Electronic Design Engineer, electrical graduate, with at least two years' experience in computer design or development. Knowledge of patents. Will develop new instruments from original specifications; build and test engineering models, for a manufacturer of electronic instruments. Salary, $6600–$8400 a year. (b) Research Physicist, at least two years' experience in electronics development or physics. Duties will include research on scintillation counters, gas flow counters and transistor circuitry. For a manufacturer of electronic instruments. Salary, to $10,000 a year. (c) Production Engineer with at least two years' experience in electronic processing or methods. Knowledge of electronic instruments helpful. Will assemble model from parts, determine best production methods, processes and tooling. Prepare parts list and redesign parts that are wrong. For a manufacturer of electronic instruments. Salary, $5400–$6600 a year. Employer will pay placement fees. Location, Chicago, Illinois. R-9780.

ELECTRICAL DESIGNER, electrical graduate, up to 40, with at least two years' experience in utility work on distribution or design. Knowledge of hydro-electric plants helpful. Duties will include design work for hydro-electric power plants and systems, for a firm of consultants. Salary, to $6500 a year. Location, Chicago, Illinois. R-9784.

DESIGN ENGINEER, electrical degree, 25–40, with five years' experience in electrical engineering. Would prefer motor design experience but may accept other electrical design experience. Duties will involve electrical design of d-c machines, 1/2 hp to 200 hp. Some customer contact and quality control supervision of units going through shop. For an electrical manufacturer of electrical motors. Salary, $7200–$9000 a year. Location, New Jersey or Iowa. T-9812.

PANEL BOARD DEVELOPMENT ENGINEER; at least two years' experience in motor design and development. Duties will include development of motors for special purpose applications. Determine hp current characteristics for given loads, feeds and speeds. Supervise small motor department developing panel boards. Salary, $5400–$6000 a year. Employer will negotiate fee. Location, Wisconsin. T-9858.

DESIGN-DEVELOPMENT ENGINEER, electronics degree, age to 40; recent graduates or better. Knowledge of mathematics and some practical work such as radio "ham" or similar basic design, research or development on electronic equipment such as d-c amplifiers or aircraft controls. For a manufacturer of electronics. Salary, depending upon experience, B.S. up to $5000; M.S. up to $6000 a year. Employer will discuss fee. Location, Chicago, Illinois. R-9874.

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For help and situations wanted, $1.50 per line. Sale and purchase of used machinery, etc., $2.00 per line, minimum 8 lines, maximum 30 lines, not available to dealers. Address orders to: Classified Section, ELECTRICAL ENGINEERING, 500 Fifth Avenue, New York 36, N. Y.

When answering an advertisement, send all replies to box number specified, c/o ELECTRICAL ENGINEERING, 500 Fifth Avenue, New York 36, N. Y., unless other address is given.

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SOUTHEASTERN UNIVERSITY has opening for Associate Professor of Electrical Engineering in communications work. Ph.D. required. Compensation including research income, $9,300. Also several openings in research division for young graduates who may obtain M.S. degree while working. Write Box 379.

SALES ENGINEER, age 25–40, some technical background desirable, to call on utility industry in midwest-southwest states from Chicago office of long established cable company. Permanent position, salary and expenses. State age, education, experience, references, salary. Write Box 388.

ELECTRICAL ENGINEER—Age 25 to 38, Fast growing manufacturer large induction and synchronous motors, generators, control and switchgear, has opportunity in Headquarters Sales Dept. for electrical engineer who wants broad type of work with contacts with all departments of company. Handle technical correspondence with sales engineers in field offices, prepare bids and proposals, and develop application engineering ability. Highly interesting nonroutine work where you can make decisions and move ahead based on your ability. Location—Beautiful land of 10,000 lakes and sky blue waters, Minneapolis, Minnesota. All replies confidential. Address Box 395.

ELECTRICAL ENGINEER—Large manufacturer of electrical insulation materials has opening for graduate engineer to work in Sales Department as contact man between our laboratories, salesmen and engineers of customers. Location in metropolitan New York City area. Submit complete resume and salary requirements. Box 396.

ELECTRICAL ENGINEER P.E. experienced in Commercial Industrial and Municipal design and consultation wanted to join active consulting engineering organization. Excellent opportunity. Location South. Salary in line with experience. Write Box 407.

TECHNICAL EDITOR, for electronics laboratory in New England city. Graduate in electrical engineering or physics preferred, 3–5 years' experience. Must be able to check, copy-edit, rewrite and set up technical manuscripts, progress reports, etc. Write Box 411.

SALES ENGINEER with knowledge of electrical signalling and control products and experience in selling to locate in small midwestern city. Some travel involved. College degree not necessary. Write Box 412 and include complete resume of background and salary requirements.

GRADUATE ENGINEERS for process and development engineering positions with Michigan manufacturer of enamel magnet wire and cable. Openings for both experienced and interested men in this field. Write Box 413 stating training and qualifications. Reply will be held strictly confidential.

UTILITY ENGINEER—A major Eastern petroleum refiner offers an excellent opportunity to a graduate electrical engineer with a minimum of 6 years' experience in design and development of electric power and steam generating units. Background must include utility balancing as related to refinery installations, offices and marine equipment. This is a new position with potential for a creative minded engineer age 30 to 40. Excellent starting salary and progressive company benefits. Philadelphia location. Send complete resume of education and experience in confidence to B-60, P. O. Box 3495, Philadelphia 22, Pa.

INSTRUCTOR OR ASSISTANT PROFESSOR OF ELECTRICAL ENGINEERING—M.S. desired with specialization in power; to teach machinery and circuits courses. Position available September 1953. Send application to Chairman, Department of Electrical Engineering, State College Station, Fargo, North Dakota.

ELECTRICAL ENGINEER: Young, resourceful, ambitious, to take charge of operation, maintenance and improvements on new atomic accelerator on the Cornell Campus. An interest in physics desirable. Outstanding opportunity to gain valuable experience working with a group of prominent nuclear physicists. Write giving complete details of education, experience and salary expected, to Mr. Diedrich K. Willers, Personnel Director, Cornell University, Ithaca, New York.

ELECTRICAL ENGINEER: Young, resourceful, for work under senior electrical engineer for one year, then to have engineering responsibility for manufacture, distribution and other electrical engineering, installation and maintenance problems on the Cornell Campus. Write giving complete details of education, experience and salary expected, to Mr. Diedrich K. Willers, Personnel Director, Cornell University, Ithaca, New York.

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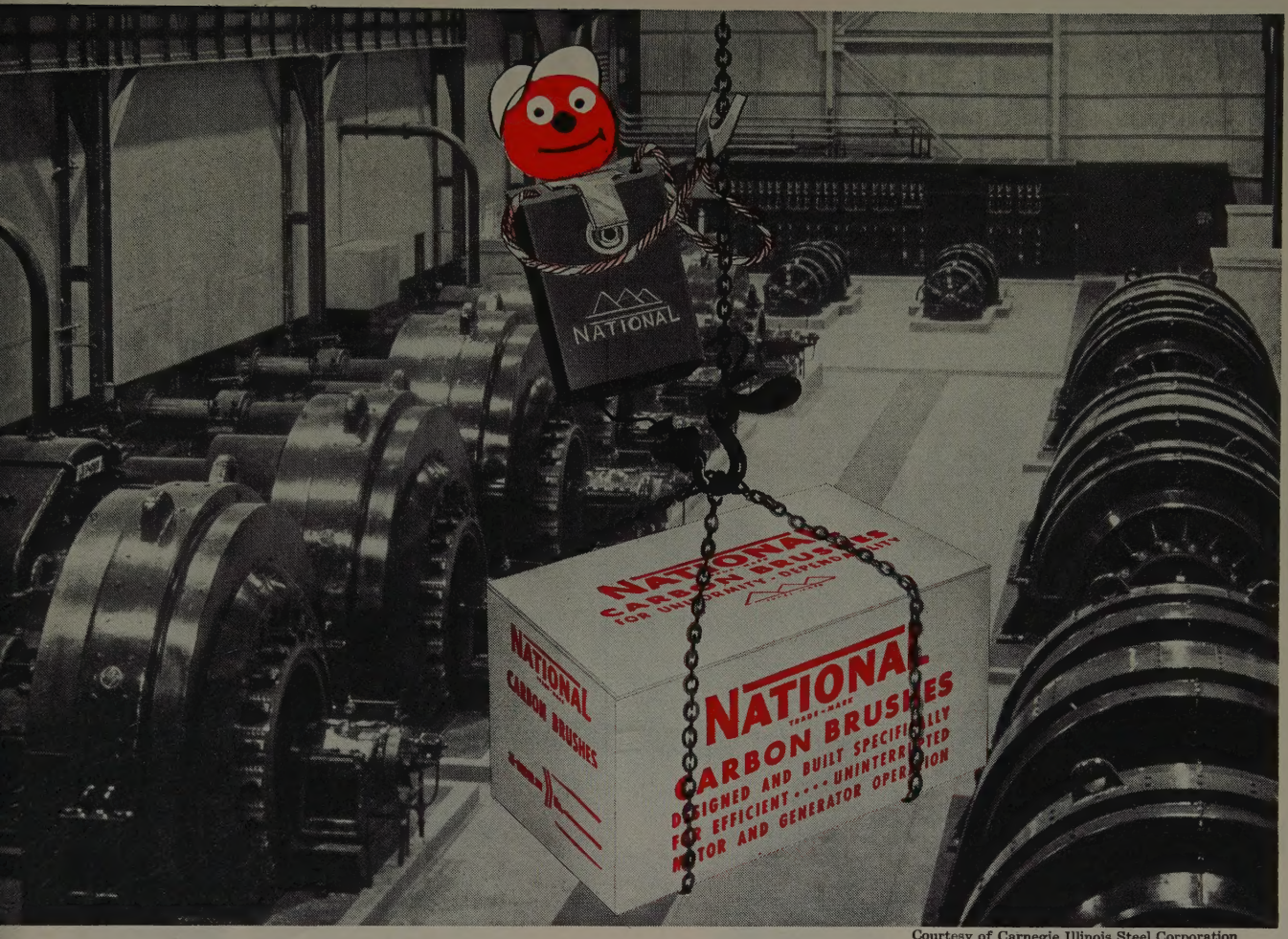

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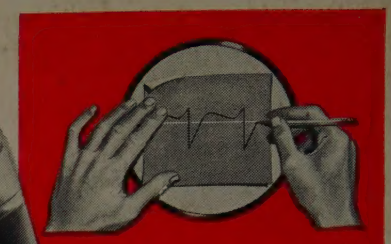

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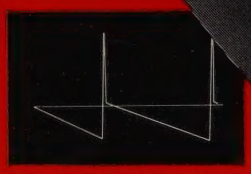

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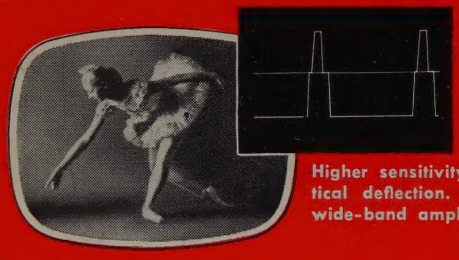

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